WOMEN AND NUTRITION IN INDIA

Edited by
C. Gopalan
and
Suminder Kaur

NUTRITION FOUNDATION OF INDIA

SPECIAL PUBLICATION SERIES 5

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From SEWA Rural.

This publication is
dedicated to
Dr. S.G. Srikantia
in grateful remembrance

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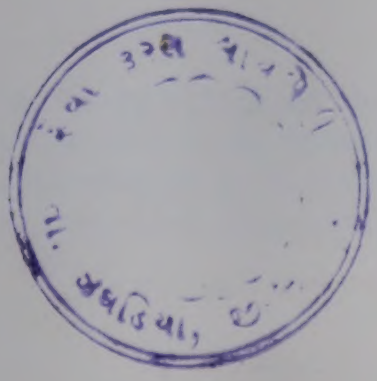


Preface

A great deal of work on nutrition (and nutrition-related) problems of women have been carried out in the country over the last few decades. This book is an attempt to critically review the data available from this work, contained in numerous scientific publications, in order to identify the major messages that stand out as also the gaps that still remain to be filled. At a time when health and nutrition problems of women are beginning to attract increasing attention from planners and policy-makers, an exercise of this nature is necessary and relevant.

Since nutrition problems have far-reaching ramifications, both with respect to their causation and effects, the range of publications which may be deemed to be related to nutrition will necessarily be very broad; under the circumstances it is often difficult to decide which publications are within the scope of nutrition and which outside. It is possible that the bibliography contained in this book includes publications which may be thought to be not strictly related to nutrition; it is also possible that a number of publications that may in fact be related to nutrition have been left out. Our attempt here is not so much to achieve comprehensive and complete coverage of all available publications but mainly to discern major leads for practical action that flow out of the several observations available.

We are grateful to the Ford Foundation for the general grant which has made this book possible. The Foundation is also grateful to the eminent contributors who had given so much of their time and thought to their contributions. They are acknowledged experts in the areas they have chosen to discuss.

In spite of editorial efforts there is some unavoidable overlap between the different presentations.

The compilation of the bibliography was carried out by Ms. Suminder Kaur of the Foundation and I wish to thank her for the hard and diligent work she has put in.

When Dr. Srikantia, an ardent friend and well-wisher of the Foundation, was invited to contribute the articles standing in his name, he responded with the same graciousness and promptness with which he had always responded to the call of the Foundation. Little did we realise then that we would lose him so soon. In dedicating this book to his memory, the Foundation, and, through the Foundation, the fraternity of Nutrition Scientists of India, pay their sincere tribute to an outstanding scientist and an upright, honest, gentle and compassionate human being.

C. Gopalan

Part I

Review of Literature

Women And Nutrition In India: General Considerations

C. Gopalan

In recent years there has been a remarkable upsurge of interest in the health and nutrition problems of women in the country, thanks to the vigorous "women's movements", which have served to highlight current disabilities of our women. In order that this new awakening is channelised into truly constructive directions, it is important that the scientific foundations of our present concern with respect to women's health and nutrition are clearly articulated and understood. The observations reported in this publication, based on several studies carried out in the country, should provide some useful pointers.

To be sure, during the last 40 years, there have been some impressive gains with respect to women's health. Life expectancy at birth for the female in the country, which stood at 31.7 in 1950, rose to 54.7 in 1980[3,4]. Female infant mortality had declined to 97 (1986) and female child mortality (0-4 years) to 38.6 (1986)[6]. But while more women are thus 'surviving', there is unfortunately not much evidence of substantial improvement in the health and nutritional status of the survivors. It is not necessary here to go over the ground being covered in the succeeding chapters; for our present purpose, two illustrative observations will suffice.

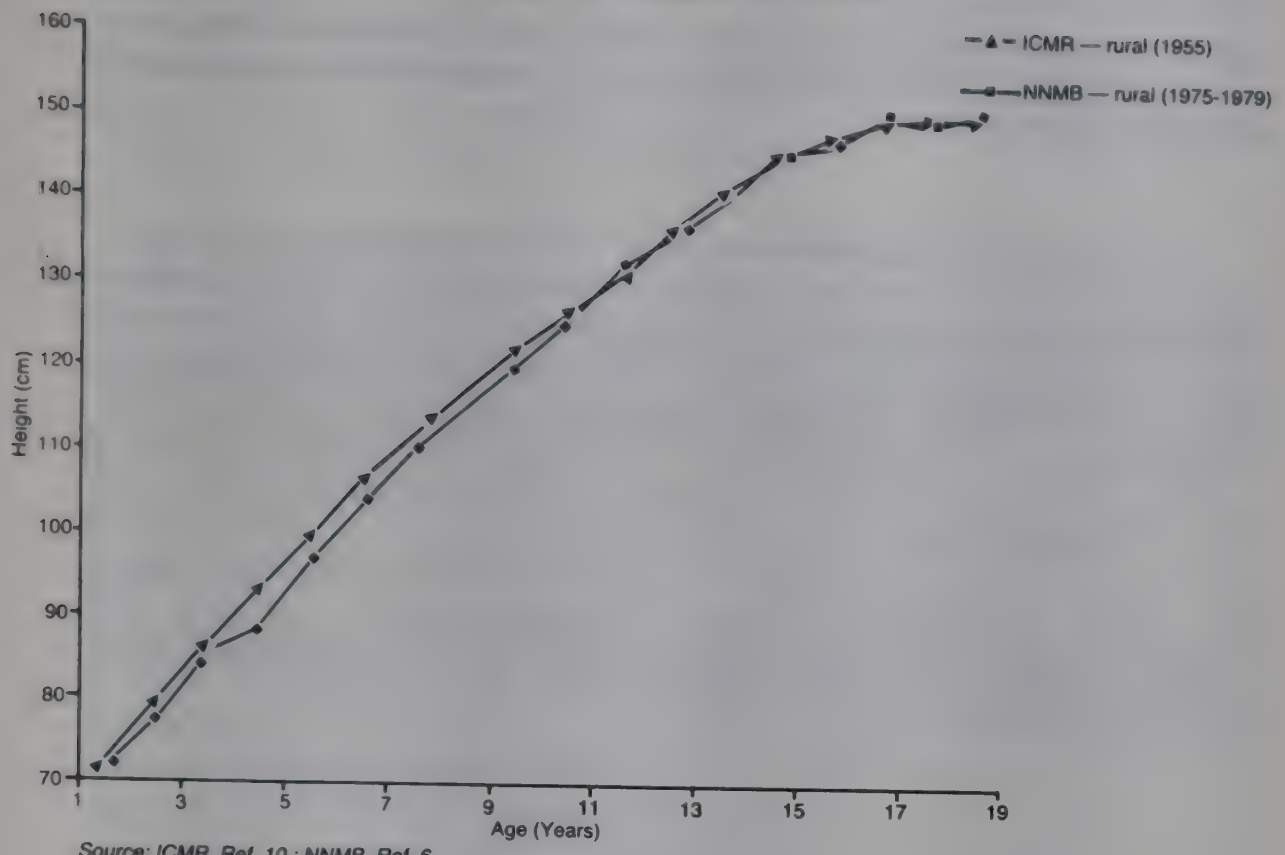
The hallmark of poor maternal nutrition and poor antenatal care in a community is the high proportion of babies born with low birth weights – less than 2.5 kg (small for gestational age). This proportion was reported to be nearly 38 percent in poor rural communities in South India in 1955[17]. Studies carried out nearly 30 years later, referred to in later chapters, indicate that the situation today is not much better. Indeed, a recent study in Calcutta[2] has actually revealed a shocking proportion of 56 percent of low birth weights among deliveries in urban slums. This figure of 56 percent is probably much

higher than what generally obtains in the country; however available evidence would suggest that it is still the case that nearly one-third of babies born in the country are of low birth weights. Low birth weight of offspring is not only an evidence of poor maternal nutritional status but is also an indicator of possible poor future development of the baby. Maternal nutritional status thus not only determines the state of the offspring at birth but also, to some extent, the future course of its development. We have, therefore, reason to feel concerned over the persistent high proportion of deliveries of low birth weight infants in the country.

The Indian Council of Medical Research (ICMR) had carried out a countrywide study of growth and development of children in 1955[10]. Almost 20 years later, the National Nutrition Monitoring Bureau (NNMB) of the ICMR had also published its findings on heights and weights of children of different ages covering a large part of the country[6]. The earlier ICMR study included both urban and rural children, the latter naturally representing the predominant part of the total sample. The NNMB study largely captured the rural communities. The values for heights and weights for age of urban children in the earlier ICMR study were marginally greater than those of the rural children in the same study. Though this difference in the sampling procedure could not have significantly vitiated the comparison of the results of the two studies, in order to fully ensure the validity of the comparison, we have taken into consideration, for the purpose of our present comparison only the earlier ICMR data with respect to rural children. It will be seen from Figs. 1 and 2 that the ICMR data of 1955 and the NNMB data of 20 years later, both of them for rural girls, are almost identical. There is no evidence of secular trends indicating improved growth performance in the succeeding generation – a feature expected of all successful developing societies. This is not surprising. Where nutritional status of mothers has shown no evidence of substantial improvement, no significant improvement in the growth performance of their children can be expected either.

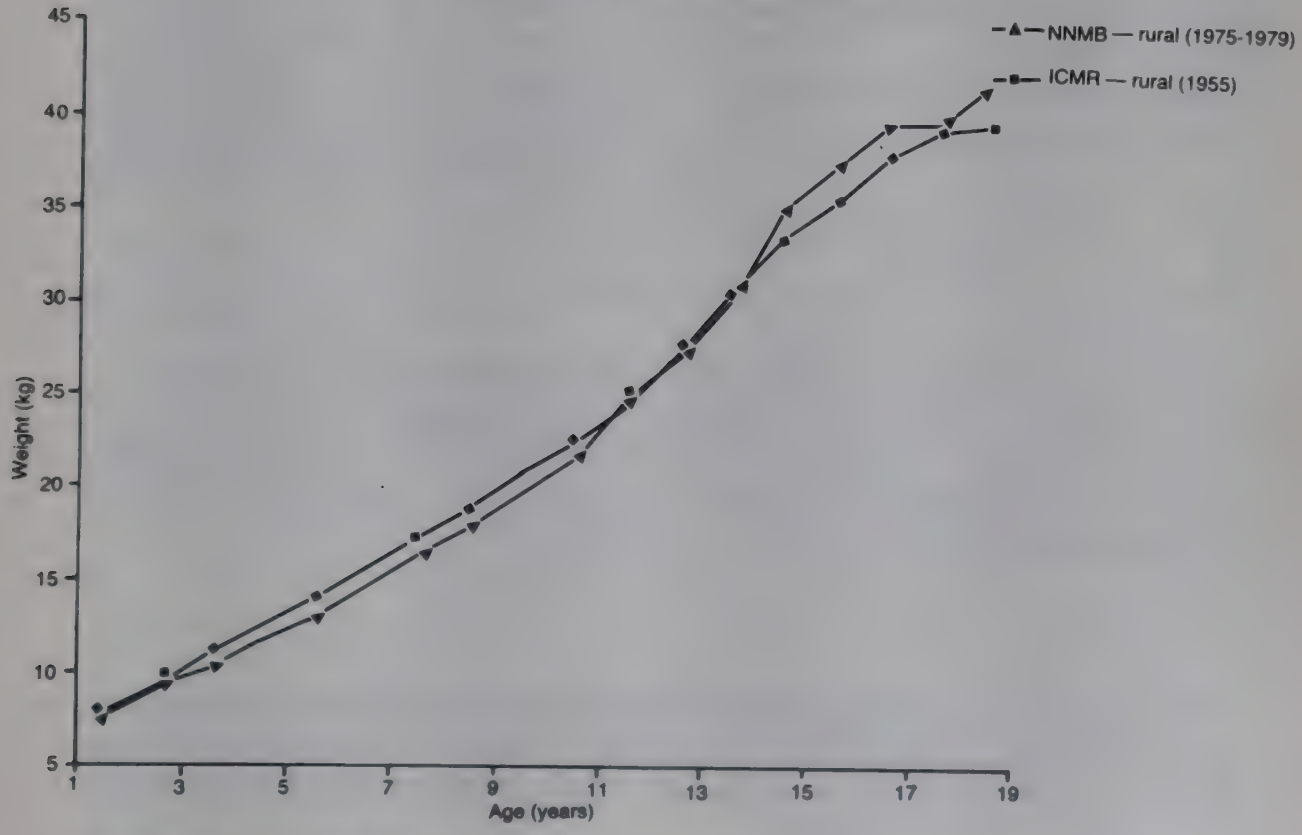
It can be computed, on the basis of available growth data, that today nearly 24 percent of adult women in the reproductive period have body weights less than 38 kg and 16 percent heights less than 145 cm[6]. These women, according to the generally accepted criteria proposed by WHO, fall into the 'high risk' category – i.e. they are likely to suffer obstetric complications and give birth to offspring of low birth weight, especially in situations where antenatal care and most obstetric services are below par. These observations broadly indicate the magnitude of the unfinished tasks with respect to improvement of the health and nutritional status of our women. Data presented in later chapters on the current picture regarding the prevalence of anaemia, maternal mortality, sex ratio and the state of health care, will serve to reinforce this broad conclusion. It must be emphasised here that poor performance with respect to upliftment of the health and nutritional status of

Fig. 1. Height of Girls



Source: ICMR, Ref. 10 ; NNMB, Ref. 6.

Fig. 2. Weight of Girls



Source: ICMR, Ref. 10 ; NNMB, Ref. 6.

women is not to be dismissed as a failure of our health system alone. It is indeed indicative of a larger failure – of our planning process itself, which has apparently failed to accord adequate focus to human resources development (of which women's upliftment is a core area) as a central objective of national development.

The wasted years of adolescence: Even with the existing levels of poverty, a significant impact of maternal nutritional status and birth weights of offspring can be achieved through just bringing about a rise in the age at marriage of our rural girls. It will be seen from Table 1 (based on NNMB data) that between their 14th and 18th years, the girls gain on an average 6.8 kg in their body weights and 5 cm in their heights. The period 14-18 years is a period of active growth for our girls. The mean age at menarche in the rural girls of the country at present is about 14 years[10]. A very large percentage of our girls are pushed into marriage very early, the marriage being consummated almost immediately after menarche. Thus, a large proportion of our rural girls embark on their arduous reproductive journey almost from their 14th year, and teenage pregnancies are the rule.

The proportion of girls who are at obstetric risk (as per the WHO criteria) at 14, 15 and 18 years of age is indicated in Table 2. The data in the table will show the remarkable impact that raising the age at marriage could have on maternal, foetal and infant nutrition even in the current context of poverty in our rural communities. Indeed, the data in Table 2 could probably underestimate the order of this impact. It must be remembered that in addition to the increased risk posed by their current immature body stature, there is also a crucial difference with respect to pregnancy as between a 15-year-old girl and an 18-year-old girl. In the latter case, there are two competing nutrient demands on the mother during pregnancy – the demand for repair and maintenance of her own tissues and the demand for foetal growth and development. In the case of the former, however, in addition to the above two demands, there is also the added competing nutrient demand of the mother for her own further growth which could be quite exacting and significant. It is not surprising for this reason that the incidence of low birth weight deliveries is significantly greater in young primipara.

The 1981 census figures show that the mean age at marriage of "currently married women" in the country, as a whole, was 16.7[4] years and the "singulate" mean age at marriage of females (the mean number of years a girl remains single) was 18.3 years[5].

In the problem states of Bihar, Rajasthan, Madhya Pradesh and Uttar Pradesh, the mean age at marriage of "currently married women" was between 15.5 and 16.2 years and the "singulate" mean age at marriage was between 16.1 and 16.7 years. It would appear that in these four states which account for a very high proportion of India's population, roughly 50 percent of girls get married before the age of 16 years.

It is unlikely that this distressing problem of early marriage will be solved through legislation. This is very much a part of the picture of prevailing socio-economic underdevelopment and must be addressed as such. We will return to this question later in this chapter.

Between 14 and 18 years, according to the NNMB data, girls of poor rural communities gain over 5 cm in height and nearly 6.8 kg[6] in body weight as against 2.3 cm in height and 3.5 kg in body weight by girls of the affluent sections of the population[9] (Table 1). This is because menarche and consequently the adolescent growth spurt is delayed by almost one year in the case of poor rural girls. Between 14 and 18 years, there is a significant degree of catch-up of the growth levels of poor rural girls with those of the affluent girls. Thus the growth process continues for a longer time in the poorer group than in the well-to-do. For this reason, it is even more important that conception is delayed till about the 18th year in the case of poor rural girls than in the case of the affluent. Actually, however, it is the poor rural girls that are married off at a much younger age and have to start their reproductive career much earlier than the well-to-do.

In our developmental programmes as they stand today there are no special efforts specially beamed to adolescent girls. These girls, having generally dropped out of schools before their eighth or ninth year, are not reached by the school system; antenatal services start only after the onset of pregnancy. The intervening crucial years of adolescence between their dropping out from school and the onset of pregnancy, during which period much can be done by way of equipping the girls for better and more productive citizenship, and safer and more competent motherhood, are truly wasted years, years of wasted opportunities. This is the basic deficiency in our present developmental system which needs to be addressed if significant improvement in the health and nutritional status of our women and children is to be achieved within the next 20 years.

Antenatal care: Today our antenatal services have not made the desired impact for the reason that our system of antenatal care is patterned on lines which may be appropriate and adequate for the affluent and not for the poor. At present a pregnant women is contacted by the health services for antenatal care (if at all) only half-way through her pregnancy. Even this 'contact' takes place in less than 15 percent of cases; and the 'contact' may be no more than one or two visitis to the Health Centre throughout pregnancy. It must be remembered that the woman is already anaemic (in a high proportion of cases) and stunted and of low body weight even at the start of her pregnancy. In the interval of barely 12 weeks between the time of contact by the health system and the delivery of her baby, even with an efficient antenatal service, it will be extremely difficult to correct, to any significant degree, the fairly large pre-pregnancy deficit that she is already suffering from and, in addition, provide for her added demands of pregnancy. Thus, a stunted woman who starts on her pregnancy with a body weight of 38 kg or less and a haemoglobin level below 8 g% is unlikely to achieve a body weight increase of more than 5-6 kg, and a haemoglobin level of 11 g %, by the end of her pregnancy with the type of inputs which our health system is now able to provide. Clearly, therefore, the answer lies in ensuring that the opportunities provided by the precious years of adolescence are not wasted by our health system. Programmes aimed at improving the health and nutritional status of girls during adolescence and programmes such as regular supply of iron and folate tablets *right through adolescence* are necessary so that the girls can enter their pregnancy with no serious initial handicaps. In such a situation, even the type of antenatal care which alone is now possible in our health system, may still prove adequate.

In our ICDS programmes (and even in the much publicised World Bank-assisted Tamil Nadu Integrated Nutrition Project), despite what the "Plans of Operations" may say, the focus on pregnant women and nursing mothers is extremely weak. The ICDS programme needs to be restructured in order to correct this major deficiency. Monitoring weight gains of women during pregnancy, improvement of their dietaries, and correction of their anaemia must figure as central items in the agenda of the programme. As far as the World Bank-assisted Tamil Nadu Nutrition Project is concerned (now that it appears that this is going to be further extended in some form) it must be ensured that the earlier obsession of the project with "growth-monitoring" of children in order to identify children who are already malnourished and "sinking" to an extent that *they* would "qualify" for food supplements is given up in favour of a more rational and scientific approach designed to *prevent* malnutrition and promote better health and nutrition in mothers and children. In short, the earlier strategy of that project of brinkmanship and rehabilitation for the narrow objective of "child survival" must now give place to a more positive strategy directed to the broader objective of health promotion and nutritional upliftment of mothers and children – a strategy that will ensure not just "escape from death" but better health and nutrition for our future generations.

Support to nursing mothers: While adolescent girls are totally out of focus in our present health system, a great deal of lip-service is being paid to nursing women with, however, no concrete action plans. While we extol the value of breast milk and laud women of our poor communities for breast-feeding their babies for prolonged periods, no special attention is being bestowed towards improvement of the health and nutritional status of the nursing mother even during the first six months of her lactation. One of the great physiological marvels, which is still not fully explained, is the fact that our poor women, despite a diet which generally provides no more than 1,800-2,000 Kcal per day with only 45 gm of vegetable protein daily, are able to produce 400 ml to 600 ml of breast milk; and are able to do so for several months together. It is to be expected that they are able to achieve this feat only at considerable cost to themselves through depletion of their own tissues. The marginal loss of body weights in the course of lactation does not fully reflect the extent of tissue depletion. A study on body composition in nursing women had shown[18] that the mean figure for the percentage of total body water in a group of poor nursing women was 59.2 against 51 reported for normal European women, indeed, in a third of the subjects studied, body water accounted for over 60 percent of the body weight. It seems possible, therefore, that the true extent of depletion of lean body mass in nursing women is being masked by concurrent absolute increase in total body water.

An important finding indicative of serious tissue depletion in these women is the evidence of markedly increased avidity for protein, as reflected by their capacity to retain high levels of nitrogen. A study carried out at the National Institute of Nutrition, Hyderabad[21], showed that at an intake of 61 g protein daily, lactating women of poor undernourished communities were in marginal nitrogen balance; when, however, the protein intake was raised to 99 g daily, there was substantial several-fold increase in nitrogen retention. A further increase of protein intake to 114 g daily was not accompanied by a further increase in nitrogen retention, showing thereby, that a level of at least 99 g of protein daily was needed in these undernourished women in order to achieve the maximal possible nitrogen retention. Apparently, undernourished nursing women, severely depleted of tissues, need increased levels of protein for correcting their tissue deficit. They are able to successfully retain the needed additional levels of nitrogen if these are forthcoming in their diets. Unfortunately, however, our supplementary feeding programmes hardly cover our nursing women to any significant extent.

The facile assumption that no matter how poorly fed the mother is she will still be able to deliver the milk her baby needs, may be wholly erroneous. Indeed, it would appear that a significant proportion of poor women in our country are currently not able to achieve the level of lactation perfor-

mance which they could have achieved if their nutrition was adequate. This inadequacy in lactation is being currently reflected in the poor growth performance of their infants.

Studies carried out under the auspices of the Nutrition Foundation of India[16] have indicated that a good proportion of poor women in urban slums and peri-urban areas of Calcutta and its rural environs were unable to breast-feed their infants for even up to two months despite their strong desire to do so. Excessive use of commercial baby foods (in a highly unhygienic manner) by the poor in the Calcutta area and the consequent diarrhoeal diseases and severe growth retardation observed in a large proportion of children even in early infancy in this region could be directly attributed to this fact. The NNMB survey data[6] also show that body weights and heights of poor women in Calcutta are poorer than those of the women of the Bombay region who are apparently able to breast-feed their infants fairly well for at least four months. So are their haemoglobin levels as well[8].

We rightly depend on breast-feeding for up to 4-6 months, as being the sheet-anchor of infant nutrition. It follows that we must also ensure that women in our poor communities are in fact not only able to breast-feed their infants adequately for at least this period but also that they do so without detriment to their *own* health and nutritional status. This apparently is not the case at present in a considerable proportion of poor women in some regions of the country.

Family planning: According to the Registrar General's Report (1984)[1], 43.1 percent of all births in the country were accounted for by births in women less than 24 years and 69.5 percent in women less than 29 years. Our family planning programmes which are largely directed to women over 30 years of age, thus, in effect, address barely less than a third of the problem – very much like bolting the door after the horse has escaped! It is not surprising that flattering official claims regarding "couple protection" rates do not tally with the actual observed impact on birth rates. Obviously many couples who do not stand in need of "protection" are now being "protected" and serve to inflate official records. Claims that several million births have been "averted", again based on the numbers of sterilisations or vasectomies suffer from obvious fallacies for the same reason.

These considerations underscore the imperative need for sex education to our teenage girls and the extension of a family planning programme – not terminal methods, but "a family planning education programme" designed to promote and propagate methods for spacing of births, including, particularly,

contraceptive procedures not dependent on drugs or gadgets, such as the "periodic abstinence method" (safe period). Such a family planning education programme beamed to adolescent girls cannot be carried out in isolation. It can only be undertaken as part of a comprehensive programme of "education for better living" and vocational training, for our rural girls, of the type which we have repeatedly advocated[12].

Anaemia: Among nutritional deficiency states currently afflicting our women, anaemia is the most widespread. Its clinical manifestations are not spectacular and for this reason the disease is often ignored. Recent studies have indicated that in states of iron deficiency apart from anaemia there are impairments of physical stamina, of learning ability, of immunocompetence, and of behaviour in general. Severe anaemia also adds to obstetrical risks. Because of its high phytate content, bioavailability of iron present in habitual high cereal diets is expected to be poor. It will be necessary to provide the additional iron needed either through a programme of fortification of some commonly used food item (like, say, common salt) with iron, or through a regular and intensive programme of distribution of iron-folate tablets to women and children of our poor communities. Though the technique for fortification of common salt with iron has been successfully developed at the National Institute of Nutrition, it would seem unrealistic to expect that an effective programme of fortification of common salt could be undertaken in the country on a scale sufficient to make a substantial impact on the problem of anaemia before the turn of the century. We will have, therefore, to rely heavily on distribution of iron-folate tablets. Unfortunately this programme, though it exists on paper, is being very tardily implemented and the latest report of the Indian Council of Medical Research on this programme makes depressing reading. The failure of this programme is in a large sense a reflection of the poor outreach of our health services.

Anaemia is at least one nutrient deficiency disease which can be controlled even in the current conditions. Every effort must be made to intensify the distribution of iron tablets and to increase the availability of these tablets for the poor. This must go hand in hand with a programme of nutrition education. Apart from health centres, *anganwadis,* rural schools, post offices and a number of public institutions could be used as outlets for distribution of iron-folate tablets. After all even before our Independence, post offices were being used as outlets for distribution of quinine tablets. It is time we invoked imaginative approaches for extending the outreach of this programme as indeed of many other health and nutrition-related programmes which are today languishing because of the inadequacy of our health system.

Endemic goitre: According to official estimates, 145 million people in the country live in goitre endemic regions and 40 million are actually suffering from goitre[13]. The National Goitre Control Programme has yet to make significant headway[11]. Recent studies [19,20] have revealed new disturbing dimensions of the problem. The incidence of neonatal hypothyroidism, as reflected in cord-blood thyroxin and thyrotrophin levels, varies from less than one percent to over 13 percent in different regions of the country. In populations with high incidence of neonatal hypothyroidism, an increased prevalence of nerve deafness and a shift of IQ of children towards lower scores were demonstrated. Thus iodine deficiency is of great public health significance and far-reaching implications. Adolescent girls and pregnant women and their offspring need to be protected. The answer lies in the vigorous implementation of the salt iodation programme. Kochupillai[19] has warned against resorting to iodine injections in pregnancy. The arguments against this approach as far as our country is concerned have been discussed in an earlier communication[13]. There are no doubts whatsoever about the efficacy and safety of the well tried out salt iodation procedure and this is what we should pursue without allowing ourselves to be deflected by powerful vested interests.

Gender bias: The major thrust of aggressive women's movements in the country in recent years has shifted towards combating "sex discrimination". It is true that in many households (if not in all) across the country, parents (both mothers and fathers) prefer to have sons rather than daughters. It is also true that where couples have already had three daughters in a row, sex determination tests are carried out to ensure that the next baby is a boy; selective abortions of female foetuses are apparently being undertaken. It also appears to be the case that women in poor rural communities seek medical assistance for illnesses of their sons more frequently and promptly than for illnesses of their daughters. These attitudes and practices will ultimately be eliminated not through sermons or legislation but only when the socio-economic compulsions and value systems which underlie them are addressed. There can be no doubt that, with better education, social reformation and increasing economic strength of women, these practices will eventually decline. Fortunately, there is evidence of such decline already. We must, of course, continue to fight these prejudices, but we must do so without losing our sense of the (total) perspective.

Sex discrimination even today accounts for only a small part of the overall disabilities that our women suffer from. Sex discrimination as a factor responsible for poor health and nutrition of our women becomes less important when compared to the overwhelming role of poverty which equally afflicts vast sections of men, women and children in the rural countryside. Poor women, like poor men, just do not have access to adequate food. No

alibis should be allowed to cloud this fact: If today sex discrimination in the country is removed overnight by the waving of a magic wand, a very large part of the current quantum of ill-health and undernutrition among our women (as indeed, among our men and children) will still remain. Indeed, studies by NNMB have shown that even as at present, there is no evidence that girls and women exhibit greater degrees of growth retardation than boys and men[22]. The subject of gender bias has been discussed earlier in the Bulletin of the Nutrition Foundation of India[14] . If the main thrust of women's movements is to ensure that women suffer only just as much ill-health and undernutrition as their menfolk and no more, they would not have achieved substantial nutritional upliftment. The disparity with respect to health and nutritional status as between well-to-do women and poor women in the country is far greater than that between poor men and poor women[15]

Data presented in later chapters will clearly show that the sex ratio is far more unfavourable to women precisely in those states of the country which are known to be "backward" in many respects. This would indicate that distorted sex ratio is a symptom of "backwardness"; the symptom will be controlled only when the root cause is addressed. What is then needed is a battle against "backwardness" as such – all-round upliftment of the society as a whole.

Women's movements must remain right on the high road as the vanguard of the fight for elimination of poverty, the correction of socio-economic inequalities in the country and the improvement of the quality of life of millions of *poor families* in the countryside. It will be unfortunate if, under the influence of the "haves" and vested interests, they get sidetracked into the alleys and by-lanes and are allowed to degenerate into yet another of the numerous "special interest" groups, fighting for narrow sectional interests. There is no inherent conflict between the needs and aspirations of women, men and children in poor households; in fact there is a congruence of interests which must be clearly recognised. It is such recognition that should inform and guide our women's movements, at least the enlightened ones among them.

This is not to say that efforts at elimination of all forms of discrimination against women, which are a blot on our society, could be slackened; they should be pursued vigorously but without neglect or detriment to the more important (in our present context) campaigns against the larger problem of poverty and exploitation of the poor by the rich.

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Health care of the people by the people: In succeeding chapters, data pointing to the current poor state of health care especially of women in the country have been highlighted. It must be clear by now that the major reason for the poor quality and outreach of rural health care and especially for the relatively poor utilisation of health services by women is that our health system is now being largely perceived by the rural communities as a bureaucratic governmental operation which must be availed of only when absolutely necessary and that too rather guardedly. The psychological distance that now seems to divide the provider and the beneficiary can only be bridged through bringing about a radical qualitative change in the basic orientation of our health system whereby health/nutrition/welfare operations at the village level become largely people's movements operated by the people for their own betterment with the Government providing such logistic, technical and financial support as may be necessary. In such a qualitative shift in the health strategy, it is the women of the rural communities that must be enabled to play the central role.

It is in this context that some of the measures recently announced by the Government must be welcomed. The efforts to decentralise planning and administration and to set up village panchayats, if faithfully implemented and not politicised, can certainly promote better community participation and involvement in health/nutrition and welfare programmes and can also ensure greater accountability. The logical follow-up of this proposal would be to set up autonomous village level mahila mandals (women's clubs) with adequate financial support and powers to be entrusted with the responsibility for all health care and nutrition programmes at the village level. All village level employees, irrespective of the Ministry that had originally recruited them, must be deemed to be employees of the mahila mandal and must be answerable to it. District and block level welfare functionaries must interact with the mahila mandals and must provide them such necessary technical service and guidance as they may need. At present, there are no effective fuctional linkages between employees of different sectors operating at the village level. Indeed, very frequently, they work at cross-purposes. This situation could be corrected through the arrangements discussed earlier.

Voluntary health brigades composed of young girls and boys in the village — somewhat like the Scout movement — could be encouraged. The recruits could be provided a general broad-based training; and from among these candidates, all recruitments to village level operations could be made with such further special training as may be necessary for the jobs to which they are being recruited.

The proposal to generate employment for women in rural areas again holds out vast possibilities. However, if this effort is not to degenerate into a populist exercise, it is important that a meaningful shelf of productive works which could be effectively undertaken by the village women and men must be carefully identified. These works must include a number of health/welfare operations as well, which are within the competence of the village people to carry out after a period of training. This again implies careful village level planning and a well-defined and well-implemented training programme. It is one thing to create jobs on paper; it is quite another to find the people who are adequately qualified to do these jobs. We already have the distressing experience that in tribal areas and among scheduled castes, it has not been possible to find girls with the requisite minimal educational qualifications who could be recruited as anganwadi workers, with the result that these qualifications had to be scaled down to the detriment of the efficiency and quality of the services. Ultimately, it is not through reservations or through putting a premium on backwardness and mediocrity, that we can expect to bring about true upliftment of women of poor communities. As important as creating jobs for women is the need to increase their *employability* through proper education and training.

A good proportion of the posts of teachers in rural schools can be reserved for rural women. This step will also help to bring about a better linkage of the rural school system with the community and a better utilisation of the schools for the promotion of community welfare.

The Nutrition Foundation of India had advocated a programme of "Education for better living and vocational training of rural adolescent girls"[12]. It is gratifying that this proposal has attracted wide attention and several programmes have been proposed on the lines of this proposal. A programme of this nature can help to generate the health brigade referred to earlier. It can also help to train candidates for specific jobs which are available. Indeed, with the announcement of the employment generation programme and the decision to reserve a proportion of the jobs for women, it will become even easier to organise a programme of vocational training for women directed to certain specific purposes.

The problems which beset women in our country are formidable, but there is no doubt that there has been a perceptible change in public opinion and in the political climate, with the result that these problems are now getting increasing attention. Specific programmes and proposals for combating the current disabilities of women, especially with respect to their health and nutrition, are being discussed more intensively today than ever before. It is to be hoped that the enthusiasm that is now being generated will lead to tangible results within the next two or three decades.

Table 1

Heights and Weights of Poor* and Affluent** Girls at 14 Years and 18 Years

Age (Years)	Height (cm)		Weight (kg)	
	Poor	Affluent	Poor	Affluent
14	145.9	156.6	35.1	47.4
18	150.9	158.9	41.9	52.5

* *NNMB (Rural — Maharashtra)*[6]
** *NFI study (SR. 10)*[9].

Table 2

Percentage of Rural Women* at Obstetric Risk at Different Ages

	Weight % below 38 kg	Height % below 145 cm
14 yrs	68	45
15 yrs	47	39
18 yrs	24	16

* *NNMB (Rural — Maharashtra)*[6]

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Demographic Consequences Of Low Status Of Women In Indian Society

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Women in India have generally enjoyed a lower "status" than men in the society. Various cultural values and social institutions have reinforced the lower status of women in comparison to men in the Indian society. Over the centuries there have been attempts by valiant men and women to rectify this situation by popular protests and scholastic writings. On the one hand, in various religious texts, the female form is worshipped as the supreme manifestation of energy and a number of festivals are celebrated for the incarnations of this energy in the form of 'Durga', 'Parvati', 'Kali', 'Lakshmi', etc. On the other hand, while the female form is thus ritually worshipped, in practice, at home, in the fields and in public places, females are subject to various forms of discrimination. Social evils, such as prohibition of widow remarriage, permission for husband to remarry when a couple has no male issue, have found a place in our society; fortunately these aberrations are now being corrected and checked.

Since the beginning of the 19th century various organised social reform movements against the suppression of women and their low status in society have been launched by social reformers like Raja Ram Mohan Roy and Maharshi Karve[3]. These reformers have played some role in changing the fundamental social and cultural system of our society; but these efforts must be continued.

The demographic consequence of the lower status of women has found expression in various forms such as female infanticide, higher death rates for women compared to men in almost all ages, lower expectation of life of females than males, lower sex ratio on the population in terms of number of females per1,000 males, lower literacy rate in females, higher morbidity rates among females, lower levels of employment of women in the non-agricultural

sector as compared to men, etc. While these indicators can be considered as primary demographic consequences of low status of women, they have also secondary or indirect demographic implications in terms of current levels of fertility, mortality and migration. For example, the prohibition of widow remarriage reduces the number of currently married women in the reproductive ages in the female population and in this sense it is a primary demographic consequence of lower status of women that prevents widow remarriage. On the other hand this reduction in the number of currently married women in the reproductive ages will contribute to reduction in the fertility levels of the population and hence the impact on fertility is also an indirect or secondary effect of the lower status of women. In this article we attempt to study the demographic consequences of lower status of women in the Indian society in the following dimensions:

- on the sex ratio of the population measured in terms of the number of females per 1,000 males in the population as a whole and in specific age groups;
- the relative mortality levels of females to males during infancy, childhood, reproductive ages and old ages;
- in the social and economic dimensions, especially in relation to literacy, school enrolment and employment in non-agricultural sectors;
- to develop a summary index of the status of female children based on the census data of 1981 and make a comparative study of different states and districts of the states in the country.

Sex Ratio In The Population

Levels and trends — comparison with other countries: The 1981 census of India revealed that there were about 331 million women and 354 million men in the total population. Expressed in terms of the sex ratio*, there were 993 women per 1,000 men in the Indian population in 1981. It must, however, be mentioned that India is not the only country where the sex ratio of the population is favourable to men. The People's Republic of China — another population giant — also reported a numerical excess of males in 1982.

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* *It is customary to depict the numerical relationship between women and men with the help of sex ratio which can be expressed as number of females per 1,000 males or number of males per 1,000 females. For the present paper the former definition has been used. A ratio of 1,000 indicates equal balance of males and females in the population, less than 1,000 denotes deficit of women (low sex ratio) and more than 1,000 indicates numerical surplus of women (high sex ratio) in the population.*

In Table 1, we provide data on the total population, number of women, sex ratio of the total population and sex ratios by broad age groups for the countries with 100 million or more population, and for the countries in the Indian subcontinent. China had a sex ratio of 948 females per 1,000 males and Pakistan 905 women per 1,000 men.

In most of the countries in the world, big and small (except for China and the Indian subcontinent) the sex ratio is more than unity, being favourable to women. That the sex composition of the Indian subcontinent (and of China) is favourable to males, is contrary to the global trend. All the censuses of India, since 1872, have recorded relatively smaller numbers of women; up to the 1971 census, this trend had accentuated in every decade.

The first census of India conducted in 1871-72 revealed that there were only 92.5 million women as against 98.0 million men, the sex ratio being 940 women per 1,000 men. Each decennial census after 1871-72, reported relatively smaller numbers of women in India. Table 2 presents the sex ratios for India as a whole from the beginning of the present century up to 2001 (projected). It can be observed from this table that the sex ratios in India were turning more and more unfavourable to females up to 1971, and only the 1981 census recorded a reversal of this trend. The ratio increased marginally from 930 in 1971 to 933 in 1981. It is expected that this increasing tendency of the sex ratio would be continued in the future. According to the population projections of the Registrar General of India, the sex ratio is expected to be around 940 in 1991 and 944 in the year 2001.

The numerical imbalance between the sexes, and the gradual deterioration since the beginning of the century, has been the concern of many scholars of the Indian population and as such the sex ratio in India has been a topic of much speculation and investigation. The results of the first Indian census conducted in old British provinces and the princely state of Mysore showing the deficit in the number of women, must have surprised the British officials associated with Indian census. The sex ratio observed in India in 1871-72 was just the opposite of what was observed in England and Wales in the 1871 census. The 1871 census of England and Wales reported, "nearly 105 females per 100 males". The British officials concerned with the Indian censuses attributed the observed deficit of females to the undercount of females which was referred to as the "systematic concealment" of the female population by the householders. The census of 1881 which covered the whole undivided India indicated a sex ratio of 954 females per 1,000 males. This time also the 1881 census report observed that "the main cause of this apparent disparity is omission to give correct count of the females"[12]. Thus by attributing the lower sex ratio mainly to the omission of females during census taking, the census authorities of earlier censuses did not accept the reality of a sex ratio unfavourable to women in India.

In the Report of the 1891 census of India, the Census Commissioner of India, while discussing the "population according to sex", stated, "We must enquire accordingly whether there are any special reasons for believing that the deficiency of women is a fact and is due to social causes such as neglect, if not the actual murder of young girls or to a normally greater mortality amongst this sex than amongst the males or finally to an initial shortness of supply"[1].

After discussing the possibility of the "concealment of women" in the census returns,Sir Edward Gaits — the Census Commissioner of the 1901 census — concluded that the concealment, intentional or otherwise, had a relatively small influence on the figures. Sir Edward, who was also the Census Commissioner of the 1911 census,stated that under-enumeration of females might be a case at the "comparatively perfunctory enumeration before 1881", but after 1881 when the census was conducted with the utmost care, "it is ridiculous to suppose that the number or any appreciable fraction of it should have escaped inclusion in the census schedule"[12(page 62)]. Thus it is clear that by this time undercount of women was no longer held as an important reason for lower sex ratios in India. The report of 1911 census has tried to investigate the reasons for difference in sex proportions in India and has enumerated a number of factors underlying the deficit of females in India. Prominent among them are: son preference, unequal treatment given to boys and girls, female infanticide, neglect of female infants, early marriages, death consequent on childbirth, bad treatment to women and hard work[12 (page 69)]. The reports of the two later censuses of 1921 and 1931 have also discussed the sex composition of population in India. The report of 1921 census observed the regional variations in the sex ratios and also took notice of the fall in the sex ratio during the past 20 years throughout the country. The decline in the proportion of women was attributed chiefly to (a) the absence of famine mortality which selects males and (b) the heavy mortality from the epidemics of plague and influenza which had selected heavily on females[12 (page 86)].

The report of the 1931 census of India carries a comprehensive analysis of the sex ratio in India. It takes cognisance of a further deterioration in the proportion of females to males that has been set in motion since 1901 and also pinpoints the reasons for this deficit and decline.

The topic of sex ratio in independent India finds a place in the 1951 census report, and according to the Census Commissioner of India, the differences in the sex ratios are to be sought in two facts: "First, males and females are not born in equal numbers; and secondly, they do not die in equal numbers either in infancy and childhood or in old age or in any particular age group or at all ages taken together" [12 (page 99)].

The 1961 census count also revealed that the long term trend of declining sex ratio in India has continued unabated. Asoke Mitra, the then Census Commissioner of India, observed, "The deteriorating sex ratio reflects on our social health, for it indicates that the risk to female lives at most ages has not improved upon that to male lives; on the contrary, it seems to emphasise that demographically we have not yet entered upon the modern industrial age with its complementary characteristics of increased risks to male and reduced risk to female lives"[12 (page 103)]. A detailed systematic analysis of the sex ratio in India, emphasising the reasons underlying the deficit of females observed from 1901 to 1961 was undertaken by Pravin Visaria[16]. This publication is the first analytical investigation into the peculiarities of sex ratio observed in India and the factors underlying the shortage of women. The results of the 1971 census of India have made known that the declining trend in Indian sex ratio has continued during 1961-71.

Differentials In Sex Ratios

Sex ratios by age groups: It has been pointed out in the earlier section that the sex ratio in India is unfavourable to women, that it has deteriorated from decade to decade up to 1971 and it has improved marginally during 1971-81. In this section we study the sex ratios at various points of the life cycle of the population considering the age-specific sex ratios. As a first step, it is necessary to understand the pattern of sex ratios at various ages that can be expected in a normal population. By a 'normal' population we mean a population which does not suffer from under-reporting of persons and misreporting of ages and where mortality rates of males and females are not affected by sex bias or by differential care of young boys and girls and those of women in child-bearing ages due to excessive and unhygienic child birth. In such a normal population, the male and female mortality rates are predominantly determined by biological factors and the level of public health which is implemented without any sex bias. The pattern of sex ratios observed in the population of the United States of America in 1985 is taken as 'normal'. The population size of the United States of America is fairly large, the effect of migration was insignificant in 1985 and there are no sex biases in health care. Table 3 presents the sex ratios by age for the populations of India, China and the United States of America (U.S.A.). It can be seen from Table 3 that the sex ratios in the United States of America (a sex bias free population) increase with age. Sex ratio at birth (of newborn babies) in the U.S.A. is favourable to males (a pattern universally observed all over the world, 925 to 950 female births to 1,000 male births) and as such at age zero i.e., zero to one year of age there are more boys than girls (sex ratio 953 girls for 1,000 boys). This numerical advantage of male children introduced at birth by biological factors wears out as age advances, mostly because of relatively higher death rates for males at each age, and continuous increase in the absolute difference between male and female death rates with age. By age 30 the

women outnumber men and this trend continues thereafter. The result is a substantial outnumbering by the fair sex in the total population (1,055 females per 1,000 males). This pattern is observed more or less in all the developed countries.

The sex ratios by age presented in Table 3 for India from the 1981 census and for China from the 1982 census, present a different pattern. It can be observed in early childhood, ages zero to four, the sex ratio was 959 girls for 1,000 boys which does not appear to be out of tune with the normal pattern. However the sex ratios for the next age group,five to nine,declines from 959 to 944 probably due to differences in female and male mortality rates in early childhood. The Sample Registration System indicated that during 1976-80 the male and female death rates for children below five were 49.6 for boys and 55.0 for girls[17]. The sex ratio further declines to 901 women per 1,000 men for the age group 10-14 and surprisingly starts rising till age group 20-25, and thereafter declines up to age group 50-54. Only in older ages after 55 a steady rise in the sex ratio is observed for India. Reasons for this zig-zag pattern can be traced partly to errors in the reporting of ages in the Indian census and partly to higher mortality rates for women up to age 50.

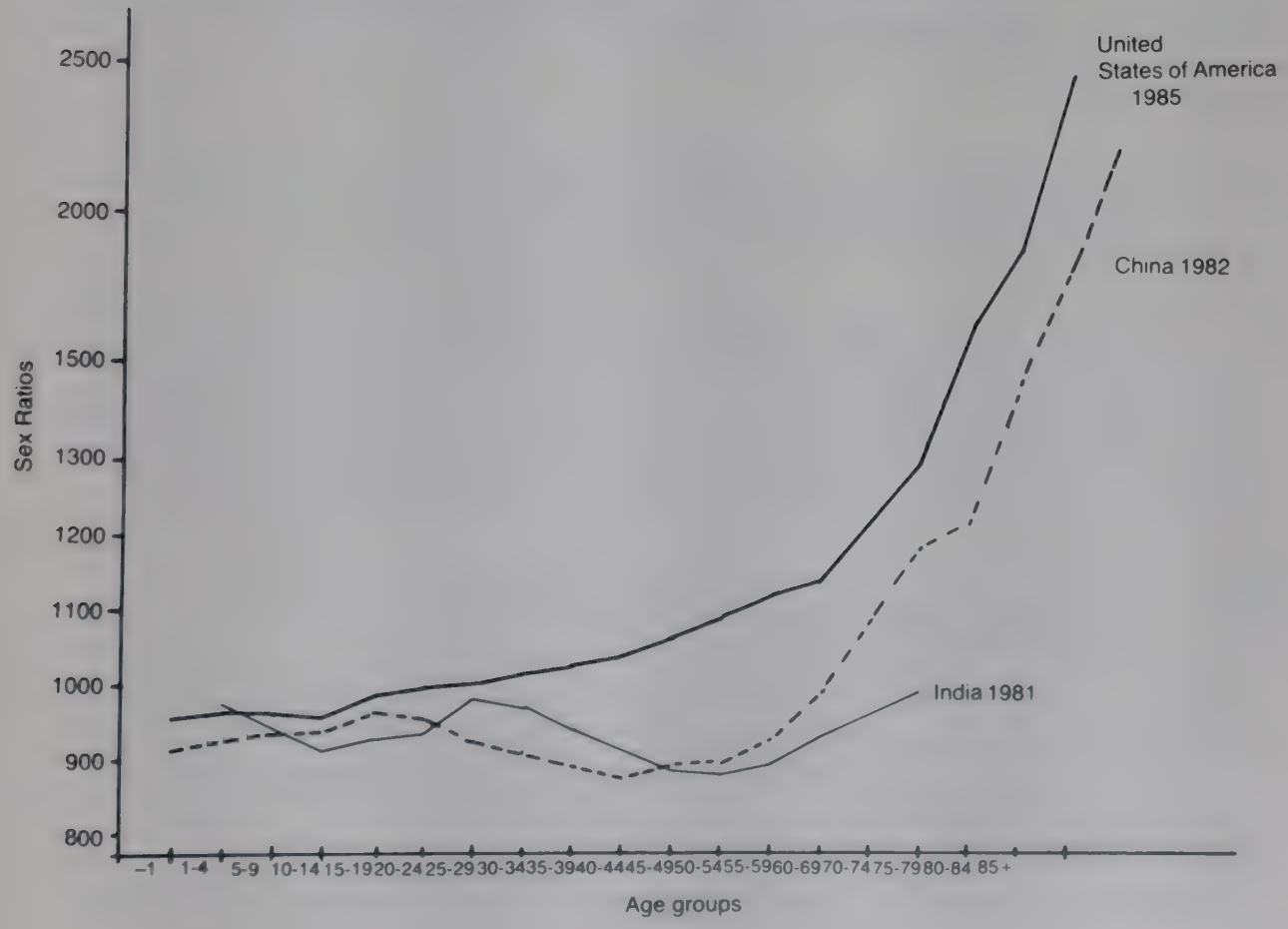
China is a country where there is also a strong sex bias (male children are preferred at all times) as in India but there are no serious errors in the reporting of age, as in India. The sex ratios by age in China, given in Table 3, reveal a steady increase from birth up to age group 15-19, declining thereafter up to the age group 40-44, and then increasing up to the end of life. The Chinese pattern indicates a very high differential in female-male mortality in early childhood and in reproduction ages. Fig. 1 presents graphically the age pattern of sex ratios of the three countries.

The difference in the pattern of age-specific mortality rates between the two sexes in India and the U.S.A. are brought out in Table 4. For India data are furnished on the age specific death rates for males and females for the rural areas for the period 1976-80 as estimated from the Sample Registration System and for the U.S.A. for 1983 as computed from the Civil Registration System. It is observed from the table that in rural India the age specific death rates have been higher for females than for males up to age group 30 to 34 and from the age 35-39 upwards there is a cross-over in the mortality pattern. In the U.S.A., however, the age specific death rate is lower for females at every age group, with no exception at all and the differential increases steadily from age one ownwards.

Interstate differentials in sex ratios: Table 5 presents data on the sex ratios by quinquennial age groups for India as a whole and the larger states on the basis of the 1981 census. It can be observed from the table that of all the states Kerala is unique in that women outnumber men (sex ratio 1,032 women per 1,000 men) and an age pattern of sex ratios which resembles, to some extent, the pattern of the developed countries. The lowest sex ratio (for all ages combined) is observed in Haryana (870 women per 1,000 men), followed by Punjab (879) and Uttar Pradesh (885). Punjab, Haryana and Uttar Pradesh have a long tradition of substantially smaller number of women as compared to men, a phenomenon that is continuing even up to 1981. However, as we shall be observing later on, the sex ratios in the states of Northern Zone (comprising Punjab, Haryana and Rajasthan) have increased since 1901. The fact that interstate net migration affects the sex ratios of various states must be borne in mind before arriving at any conclusion on the time trend in sex ratios of individual states.

Regional variations in sex ratios: The trends in sex ratios by various geographic zones of the country are presented in Table 6. The data indicate that there are wide variations in the sex compositions of different zones. The

Fig. 1. Sex Ratios for Various Age Groups for the United States of America (1985), China (1982) and India (1981)



outnumbering of females by males is most marked in the Northern Zone which had a sex ratio below 900 females per 1,000 males from 1901 to 1981. It is worth noting that the sex ratio in the Northern Zone has recorded a rise from 874 in 1901 to 898 in 1981, whereas in all other zones the sex ratios have decreased during this century, though the ratios are higher than the Northern Zone. For 1981 the highest sex ratio is observed for the Southern Zone (981) followed by Eastern and Western Zones with identical sex ratios of 939. It can also be noted that the Southern Zone had always recorded the highest sex ratio among all the zones, but it is perplexing that the sex ratios in this zone have been declining since 1901. Fig. 2 provides a graphic presentation of the trends in the sex ratio in the different geographic zones of the country since 1901.

Differentials by religion and caste: In Table 7 we present the sex ratios of the populations classified by various religious affiliations, at three points of time i.e., 1901, 1951 and 1981. Fig. 3 gives a graphic representation of the trends in the sex ratios of the populations of various religious groups from 1901 to 1981.

From Table 7 and the graph the following findings emerge. The Sikhs continue to have a markedly smaller number of females as compared to males (880 females per 1,000 males in 1981), though over the past 80 years the sex ratio of the Sikh community has improved considerably — from 767 in 1901 to 880 in 1981.

The sex ratios among the Hindus had declined over time up to 1971 and subsequently has increased to 933 females per 1,000 males in 1981.

The sex ratios of the Muslim population which was observed at 939 females per 1,000 males in 1901, deteriorated to 904 in 1951 and started increasing subsequently to 939 in 1981 and declined marginally thereafter to 937 in 1981. Sex ratios among Christians have increased over time from 939 in 1901 to 992 in 1981, though there were some fluctuations in between.

The British officials associated with the Indian censuses were deeply interested in the Indian caste system and data on castes were collected in each census of India up to 1941. These data on castes were painstakingly cross-tabulated with important demographic and social variables such as age, sex, marital status, literacy, etc. The sex ratios for selected castes by broad age groups were presented for various provinces in the Report of Census of India 1911.[7] The practices regarding female infanticide had also been discussed with particular reference to different castes. In the 1931 Census Report, the

Fig. 2. Trends in Sex Ratios for Different Regions (India)

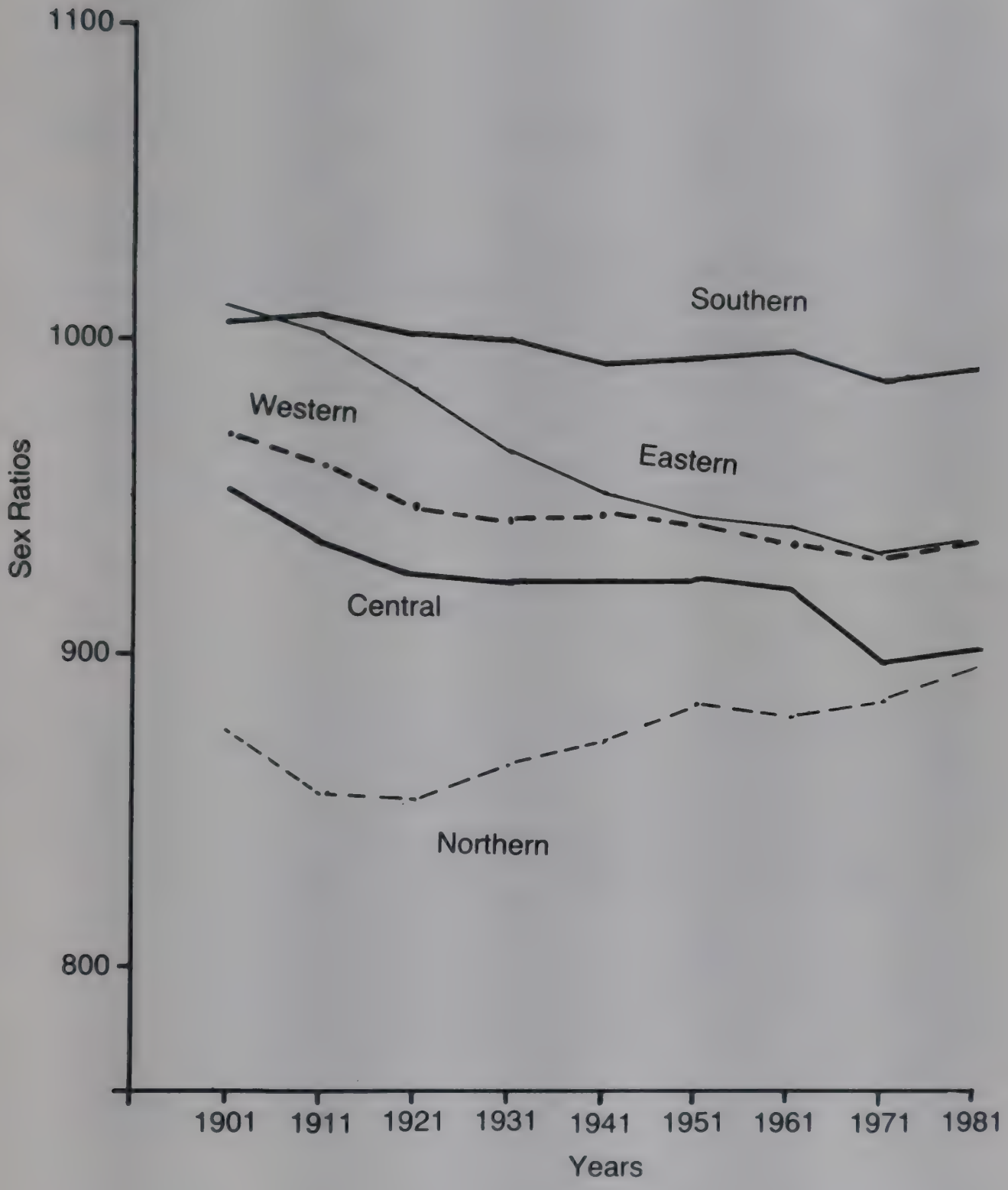
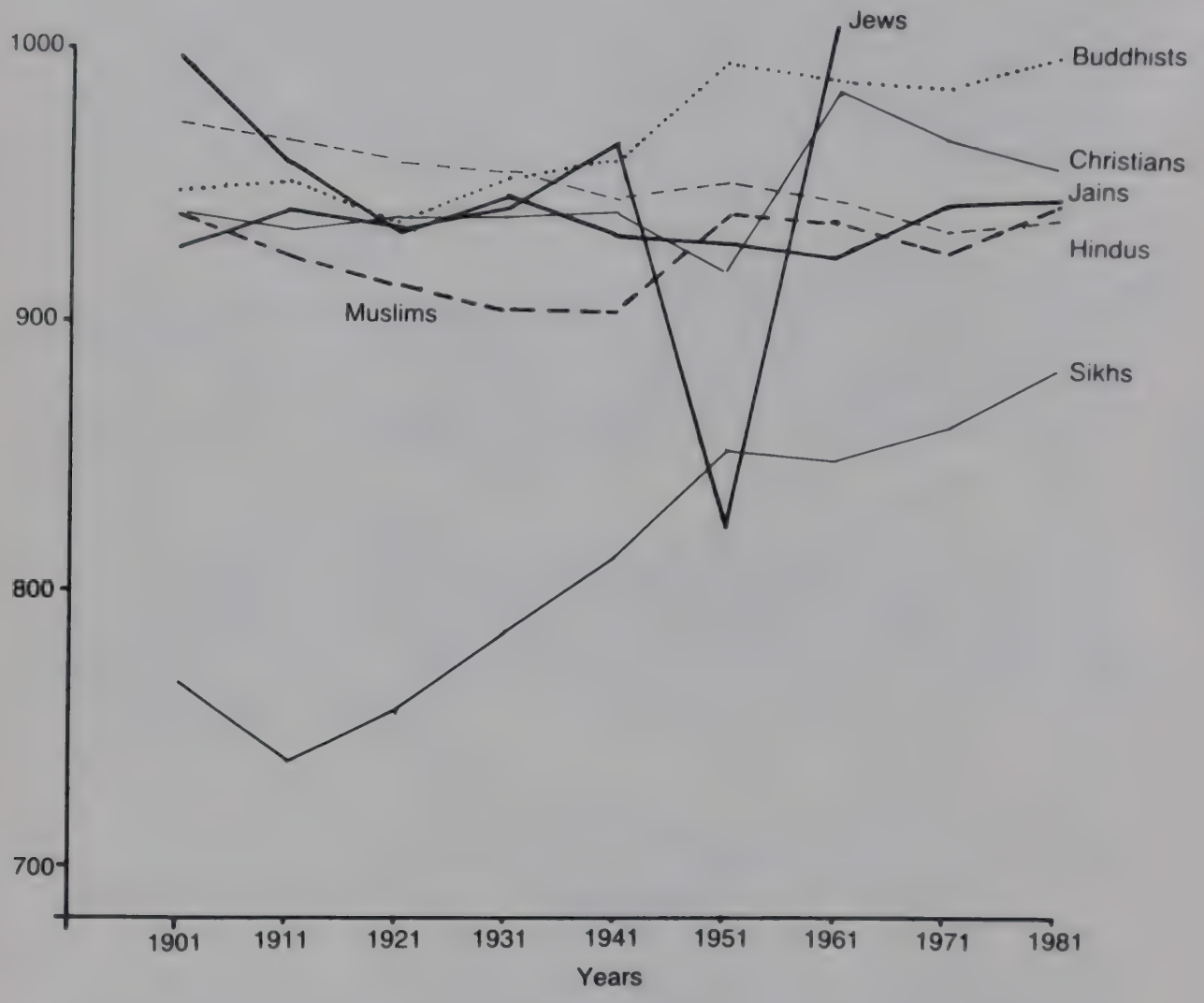


Fig. 3. Sex Ratios of Various Religious Communities 1901-1981 (Female per 1000 males)



number of females per 1,000 males has been presented for some important castes in India.These figures are reproduced in Table 8. The lowest sex ratio of 798 females per 1,000 males was observed for Rajputs followed by Jats (805). The castes, Mahar, Maratha, Sawara, Gond, Nayar, Tanti had recorded excess of females to males in 1931. Based on these data J.H. Hutton, the then Census Commissioner of the 1931 Census of India, had drawn the general conclusion that there was an inverse relationship between the sex ratios and caste hierarchy. The higher castes tended to exhibit a lower sex ratio and the lower castes a higher sex ratio, implying that the status of women was relatively lower among the higher castes than in the lower castes[10]. In support of this observation he had also presented some figures on sex ratio by social status. In Bombay, the Hindu community was classified in four groups,namely,advanced, intermediate, backward and depressed according to education and social status. For the advanced castes, the sex ratio was found to be 878; for intermediate castes it was 935; for aboriginal tribes, it was 956; for other backward communities it was 953, and for depressed classes, it was 982. Those cultural values and religious beliefs that were responsible for reducing the status of women in relation to men, were more forcefully operating among the higher caste Hindus than among the lower caste groups.

Sex Differentials In Mortality

Infant mortality*: Table 9 furnishes figures on infant mortality rates (IMR) for male and female children in India as a whole, and for 17 major states for the years 1973 and 1984. For both these years, the relative risks (RR) of infant mortality for a female child defined as the ratio of the IMR of female children to the IMR of male children, are also furnished. A relative risk value of more than one indicates a higher risk for a female child dying within one year of age compared to a male child. In 1973, the female child had a higher RR value of 1.022 i.e., only 2.2 percent higher IMR values and in 1984, there was no differential between the female and male infant mortality rates. In 1984 the maximal relative risk of the female child dying in infancy in terms of RR values is observed in the states of Punjab (1.16), Rajasthan (1.12), Madhya Pradesh (1.11) and Uttar Pradesh (1.10). The lowest relative risk for female infant mortality is found, as expected, in the state of Kerala with RR value of 0.86.

**Some of the discussions in this paper are based on the Registrar General's 1984 report. Subsequent to the preparation of this paper, the 1986 Registrar General's figures for relative risk of female to male mortality are available. However no significant difference is observed between the figures for 1984 and 1986. We therefore present only the 1984 figures which have been discussed by the author.*

– Editor

From Table 9, it is gratifying to note that the relative risk of female infant mortality has declined in a number of states during the period 1973-84, indicating lowered discriminatory practices and better care of female infants. The decline in RR value is most striking in the states of Punjab, Rajasthan and Uttar Pradesh. In Haryana, surprisingly, there is a rise in the relative risk of the female child from 1.080 in 1973 to 1.217 in 1984. Even in absolute terms, the infant mortality rate during this period has increased for a female child. This needs further investigation.

Similarly, the relative risk for the female child dying in infancy has increased substantially in Jammu and Kashmir from 0.970 in 1973 to 1.123 in 1984. Both for male and for female children, the infant mortality rate has increased during the period 1973-84 in Jammu and Kashmir. This also needs further investigation. The maximal decline in the relative risk is again observed in the state of Kerala from 0.862 in 1973 to 0.676 in 1984. The infant mortality rate in Kerala for females has declined by more than 50 percent during the period 1973-84. This indicates that when the infant mortality rate declines below a particular level, the pace of decline is likely to be higher among the female children than among the male children. The biological superiority of the female child tends to assert itself. This is also substantiated from the finding that even in developed countries, the infant mortality rate is lower for female children than for male children. At high levels of infant mortality, the environmental and social forces come into play and the female child tends to suffer more hazards of the adverse social and cultural environment.

Table 10 presents data on the infant mortality rates of male and female children divided into neonatal mortality rate (defined as death of an infant within 28 days of birth) and post-neonatal mortality rate (death of an infant within 28 days to one year of birth). The rates compiled from available published records during recent time periods for four South Asian countries, namely Bangladesh, India, Pakistan and Sri Lanka are furnished. The table also provides the rates separately for male and female children and the relative risk (RR) of female to male. One interesting finding from this table is that in all these four countries, the relative risk of neonatal mortality for a female child compared to a male child is significantly less than one. The RR values vary from slightly less than 0.8 in Pakistan to 0.93 in a population surveyed in Sultanpur. In most of the areas studied, the relative risk is found to be less than 0.9. Since the factors that govern the neonatal mortality for the child are largely endogenous, the inherent advantage of a female child to survive the first month of its life compared to a male child is brought out in this table. On the other hand, the relative risk at the post-neonatal period varies widely even among these four countries depending on their level of mortality. In Sri Lanka, where the infant mortality rate is around 30 per 1,000 births, the RR value for the post-neonatal period, is less than one, whereas in the Kadhipur Primary Health Centre of Sultanpur District of Uttar Pradesh, where the

infant mortality rate for females was over 150 during 1974-77, the RR value was 1.158, indicating that the post-neonatal mortality rate for a female child is 15.8 percent more compared to a male child in this area. Thus, we can infer from this table that in South Asian countries, which have a common culture of patriarchal system, the relative risk of mortality of a female child to that of a male child tends to go down even below one, with reductions in the overall levels of infant mortality rate. The reduction is likely to occur more dramatically in the post-neonatal period and the biological advantage of a female child will assert when the overall levels of mortality are brought down.

Child mortality: Table 11 presents the relative risk values of female to male mortality in childhood age groups zero to four, five to nine and 10 to 14 for various states separately for the rural, urban and combined areas, for 1984. The biological advantage of a female child, during the neonatal period, noted earlier, tends to disappear with the increase in age when the influence of various social and cultural factors discriminating against female children come into operation. There appear to be very little difference in the relative risk between rural and urban areas in the first 10 years of life but there is a slight decline in the relative risk in the age group 10 to 14 in the urban areas, though the RR value continues to remain more than one.

Among the states, the highest relative risk in these three age groups is observed in Uttar Pradesh in the age group 10-14 where it is 1.77, indicating the probability of a female child dying in this age group to be 77 percent more than for a male child dying in the same age group. Though part of this excess in female mortality rates can be attributed to sex-selective errors in the age reporting, it has to be realised that such large differences between the female-male risks cannot be ignored. The second higher RR value is again perceived in the age group 10-14 for Andhra Pradesh at 1.57. Those states where the mortality levels are high, the relative risks of female mortality are also high in the age groups zero to four and five to nine, implying a strong neglect of female children in high mortality conditions. The lowest relative risk is observed in the state of Kerala in the age group zero to four at 0.71. Even in this state, in the age group 10-14 the RR value is found to be higher at 1.8, but the overall mortality levels in this age group in Kerala are so low that even small errors in the reporting of ages could have distorted the RR values substantially. When we study the relative risk of female mortality for rural areas, separately, in the country as a whole, the RR values are 1.09 in the age group zero to four, 1.29 in the age group five to nine and 1.29 in the age group 10-14. There is a sharp rise in the relative risk with the rise in the ages during childhood. Among the states, in rural areas, for the age group zero to four, the lowest relative risk is again in Kerala at 0.70 and the highest in Haryana at 1.37. The high relative risk in Haryana of the female child is a significant finding worth a detailed investigation. Haryana seems to maintain

high RR values in female mortality, even in age group five to nine and 10-14, at 1.33 and 1.43 respectively. In the rural areas, the highest relative risk is observed in the age group 10-14, in Uttar Pradesh at 2.06 and the lowest, surprisingly, 0.56 in Maharashtra.

The most significant conclusion that can be drawn from the analysis of relative risk in childhood ages in rural areas for the states is that the values are over one in most of the states, indicating a widespread higher risk of female mortality in relation to male mortality in the childhood ages.

If we study the situation in the urban areas for which the relative risk factors are given in Table 11, it can be seen that the lowest values are observed again in Kerala in the age group zero to four and for Maharashtra in the age group five to nine. The striking finding of the situation in most of the states is that the values are more than one in most of the states, indicating that the even in urban areas, there is a higher risk of female mortality compared to male mortality in childhood ages except in the states of Kerala and Maharashtra. Since the overall mortality in urban areas is significantly lower than in the rural areas in the childhood ages, this indicates that even with urbanisation the discriminatory practices against female children tend to persist in our country.

A second method of studying the trends in relative risk of female mortality in childhood ages compared to male mortality is to use the estimates of q(1), q(2), q(3) and q(5) – probabilities of dying within ages, one, two, three and five derived for males and females separately from the 1981 census data at the district level. The 1981 census included questions on the number of children born and the number of living children (both sexes) for all ever-married women in the reproductive ages. The information so collected was used to estimate child mortality levels through indirect methods at the district level. Such estimates are available for all the districts of the country[2].

A summary of the distribution of the number of districts in three categories, namely, RR value more than one (female mortality greater than that of male), RR value less than one and RR value almost equal to one was done for q(2), q(3), and q(5) and the data presented in Table 12. It can be inferred from this table that the relative risk of female mortality increases with age, from one to five. The proportion of districts which had RR values more than one for q(2), namely higher probability of dying within age two for females compared to males was 35.3 percent, and this proportion increased to 42.8 percent for q(3) and further to 55.7 percent for q(5). Thus, with increase in the age of the child, there are larger number of districts with relative risk of mortality for the female child higher than that of male. Discriminatory practices against the female child tend to worsen with age in childhood. If tables

similar to Table 12 are analysed, using the state level data, different pictures emerge for different states. For example, in Kerala, out of 12 districts 11 have recorded lower RR values for q(2) and all the 12 districts have lower relative risks for q(3) and q(5). In Andhra Pradesh of 23 districts the R R values of q(2) and q(3) were less than one in all districts and for 20 districts, the RR values for q(5) were less than one. On the other hand, in Haryana, out of 12 districts, all the districts had RR values greater than one at all levels of child mortality, q(2), q(3) and q(5). In Uttar Pradesh, out of 56 districts, 46, 48 and 53 had RR values greater than one for q(2), q(3) and q(5) respectively.

Adult mortality in reproductive and older ages: Table 14 provides the RR values for India as a whole and the larger states in the quinquennial age groups in the reproductive period of life. It can be seen from this table that the risks of mortality for females are considerably increased during the reproductive ages because of hazards of pregnancy and childbirth. In India, where most of the deliveries are domiciliary and are attended by unskilled personnel such as untrained *dais* and elderly relatives, the risks of haemorrhage and infection during and after delivery are considerably increased. Further, the maternal depletion caused by repeated pregnancies in mothers who are already malnourished, increases the subsequent risks of infection and mortality. From this table, it can be seen that the relative risk of female mortality for the country as a whole is between 1.40 and 1.36 in the age group 15-29. In other words, in this age group, when women experience their peak fertility, they suffer about 40 percent higher risk of mortality than men. In ages 30-34 the relative risk declines to 1.09 . In the age group 35-39 and from 40 onwards, the relative risk of female mortality is less than one, 0.82 in the age group 40-44 and 0.67 in the age group 45-49. Thus we can see that for the country as a whole, the relative risks for prime reproductive ages are quite high.

Analysis of data by states indicates that only in the state of Kerala the relative risks for females are considerably lower than men in every quinquennial age group from 15 onwards. From age 30 onwards, the relative risks are less than 0.5 indicating that the mortality among women is less than 50 percent. This can be partly attributed to the lower levels of fertility in Kerala and partly to the provision of better health care,especially maternal care. On the other hand, in Uttar Pradesh the relative risks are consistently greater than one in every quinquennial age group including 40-44, where the RR value is 1.04. In Haryana, where as it was pointed out earlier, the RR value of child mortality was quite high, the RR values in the reproductive ages are also high until the age of 40. This analysis of data on the fluctuations of RR values from one age group to the next implies that there are large errors in the reporting of age within the reproductive period. It can also be observed that those states

which have been more successful in family planning programmes by raising the Couple Protection Rate, are also found to have lower RR values for women above the age of 35.

Table 13 provides data on the age specific death rates for males and females in broad age groups, zero to four, five to 14, 15-34, 34-39 and 50+ and the relative risk for females. The data provided for the years 1981 and 1986 show that the RR values have remained almost the same in all the age groups during these six years.

Long-term trends in expectation of life: Table 15 provides data on the expectation of life at birth (longevity) for males and females in India estimated between 1941-81 from the census data and projected after 1981 for the year 2001 by the Registrar-General.The expectation of life for males and females during the intercensal decade has been derived using the age distribution of the successive censuses. From this table, it can be seen that until 1981 the intercensal estimate of expectation of life for males was higher than that of females,indicating higher overall mortality levels for females than males. The sample registration data for 1981 has indicated a crossover wherein the female expectation of life has marginally exceeded that of the male for the first time, with expectancy for males as 54.1 and for females as 54.7. There are indications that the expectation of life for females in India crossed the male values during the late '70s[4].

Sex differentials in socio-economic conditions: The impact of lower status of women on indicators of mortality and sex ratio in the population can be considered as relatively long-term impacts. It is possible that the status of women could continue to remain low, but their mortality conditions could improve substantially owing to large scale public health programmes, water supply and sanitation and control of communicable diseases that influence mortality conditions for the whole population, men and women without altering the status of women. Thus the relative risk of mortality of women in different age groups is only an indirect indicator of the long-term prevalence of lowered status of women. The immediate impact of improvements in the status of women in a developing society like India can be felt in the school enrolment ratios in the age group five to 14, employment of women in non-agricultural sectors, etc.

Table 16 provides data on a number of demographic and socio-economic indicators circa 1981 for India and the larger states. The demographic indicators include sex ratio in the age group zero to nine and the ratio of probability of survival of a female child at age two $P_f(2)$ to the probability of a male

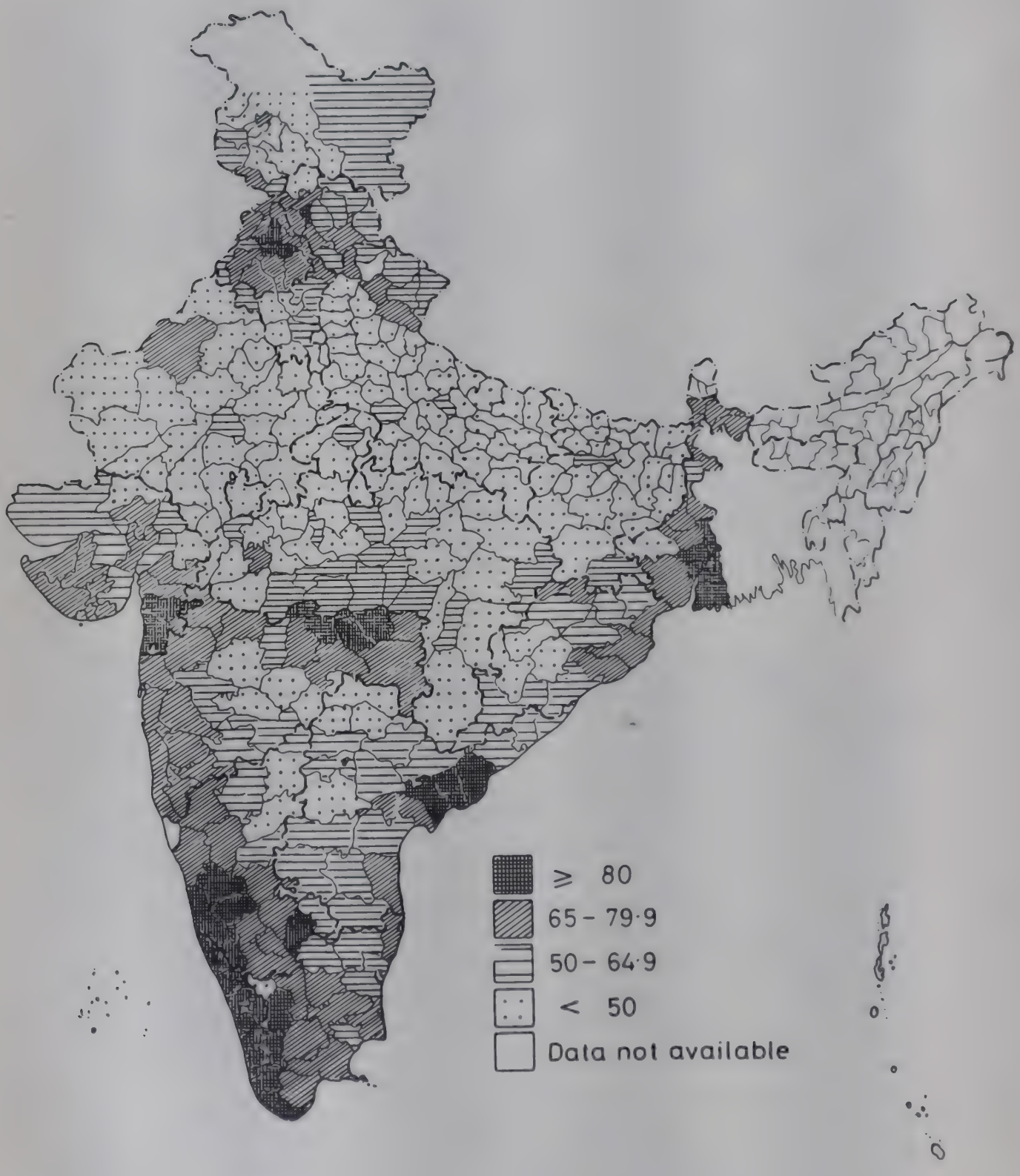
child surviving at age two $P_m(2)$. Two literacy indicators are used; one is the general literacy ratio of females to males, and the other, the school enrolment ratio of female children to male children in the age group five to 14. The employment indicator used was the proportion of females employed in non-agricultural sector to males employed in non-agricultural sector. From this table, it can be seen that in terms of literacy ratios and school enrolment ratios, the values are less than 100 for all the states, indicating low levels of education for women as compared to men. In the country as a whole, the literacy ratio is 53 percent and the school enrolment ratio is 60 percent. The maximum values of these ratios are observed, as expected, in Kerala which has 87 percent in terms of literacy ratio and 96 percent in terms of school enrolment ratio. The four states in the Hindi speaking belt, namely Bihar, Rajasthan, Madhya Pradesh and Uttar Pradesh, all have these ratios below 50 percent. Map 1 provides district level enrolment ratios for 1981.

With regard to the ratios of female employment in the non-agricultural sector compared to male employment in the non-agricultural sector, higher ratios are observed for the states of Kerala, Karnataka, Andhra Pradesh and Tamil Nadu. In all the states, the ratios are quite below 20. The states of Uttar Pradesh and Haryana have ratios below 10 percent.

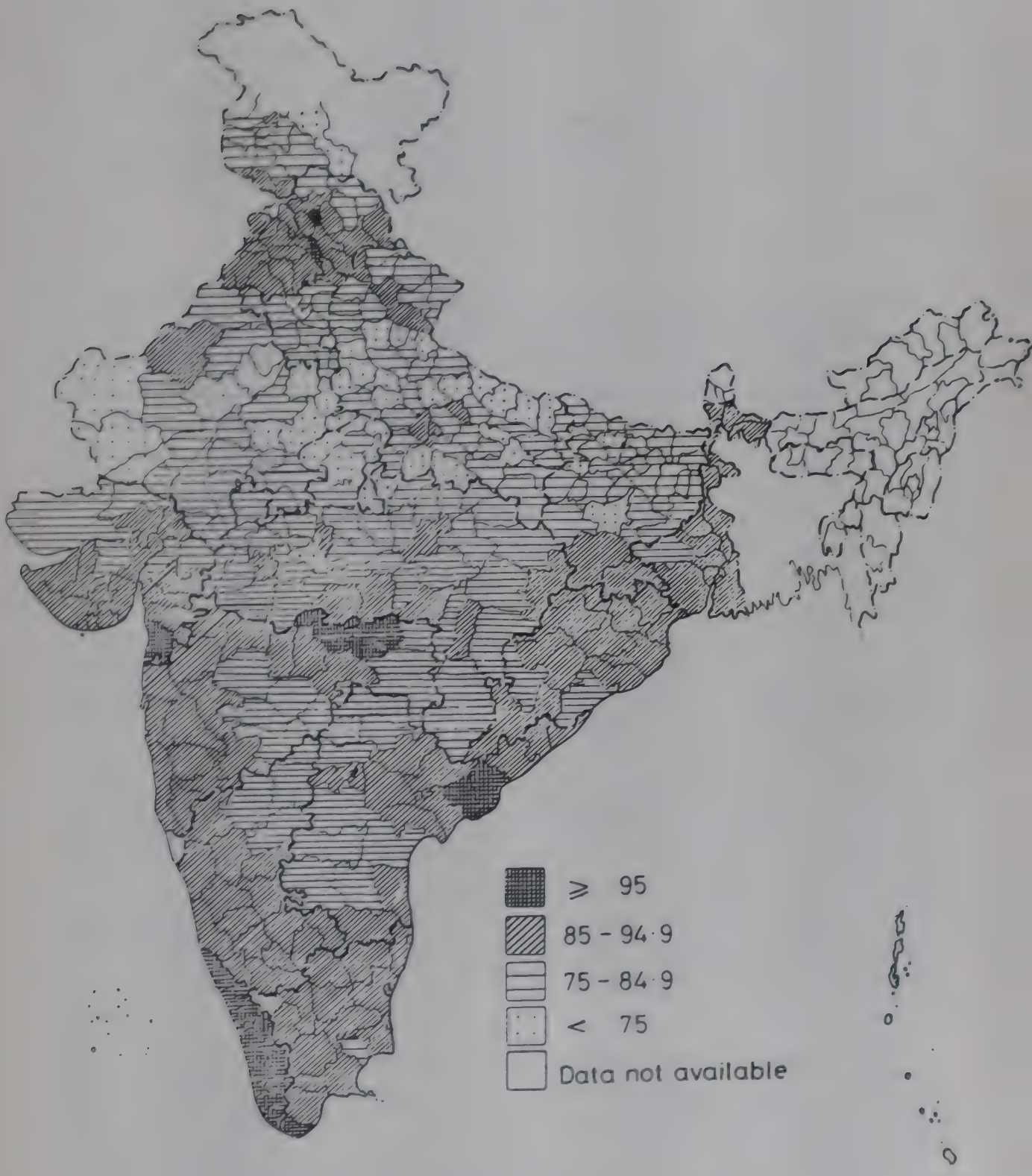
The relative ratios of survival at age two of a female child in comparison to a male child are also furnished in Table 16. They indicate that on the whole, the chance of survival of a female child at age two is almost the same as that for a male child. The ratios are close to hundred in most of the states. Thus, in terms of child mortality till age two, the differentials between male and female children seem to be disappearing since 1979-80. Table 16 also presents the status of female children index (SFCI) combining the three ratios, namely sex ratio in the age group zero to nine, school enrolment ratio, and the child survival ratio, by giving equal weights to these three components and summing them up. SFCI value of 100 indicates no differential in the status of female and male children. For the country as a whole, the index is found to be 86 which can be considered as a rough index of the status of female children in relation to male children. The score varies from 76 in Rajasthan and Uttar Pradesh to 98 in Kerala. This SFCI index was computed at the district level from the data available on these three component values for each district from the 1981 census, and a map indicating the status of female children at the district level is presented (Map 2). From this map it can be seen that the status of female children based on the index is highest in Kerala and some districts of Assam and West Bengal and the lowest in most of the districts of Bihar, Rajasthan, Uttar Pradesh and Madhya Pradesh.

Map 1. District Level School Enrolment Ratio, India, 1981

Female enrolment ratio as percentage to the male enrolment ratio



Map 2. District Level Status of Female Children Index (SFCI), India, 1981



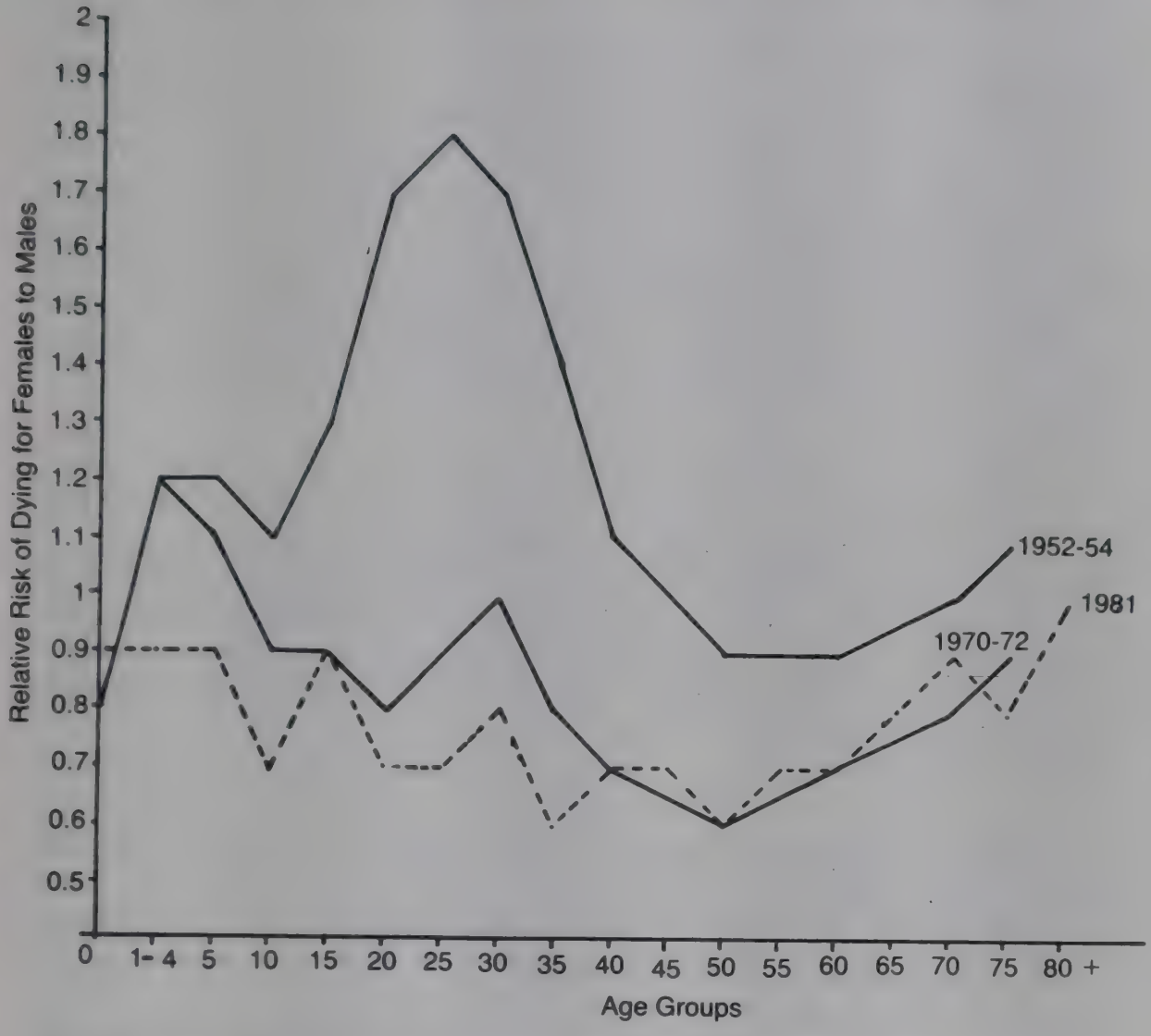
Discussion On The Findings

The findings presented in the earlier sections reveal that historically females had higher mortality rates than males and this excess was felt from birth until relative old age after the age of 50. The death rates of women over 50 were lower than men even under high mortality situations because survival at age 50 among women represented relatively sturdy women surviving very high mortality until that age. It was also pointed out that the female mortality rate was often lower than the male mortality rate in the neonatal period. Thus, even in the very high mortality situation, female mortality rates were lower than male mortality rates during the neonatal period, and after the age of 50.

With the implementation of public health programmes, maternal health programmes and family planning programmes, the age at which female mortality rates became lower than male mortality rates was brought down from 50. Recent data on the age specific death rate compiled from the sample registration system 1984 reveal that, for the country as a whole, female death rates became lower than male death rates after the age of 35. However, there are substantial interstate variations in the age at which female death rates become lower than male death rates depending upon the levels of mortality of the state. In Kerala, for example, where the overall level of mortality is quite low, female death rates were lower than male death rates after the age 10, whereas in Uttar Pradesh, female death rates became lower than male death rates only after the age of 45. Thus, we see a phenomenon which can be purely attributed to demographic trends initiated by public health programmes,maternal health programmes and family planning programmes whereby the age at which the female death rate becomes lower than the male death rate and is pushed down to lower ages starting from the age of 50. When such a lowering of the 'crossover age' of male and female mortality occurs, it is possible that the expectation of life of females could become even higher than that of males, but such a situation need not necessarily indicate a relatively higher status for females in the society. Sensitive indicators of higher status of females in Indian society can be considered in terms of mortality risks of female children to those of male children below the age of 14, especially the childhood ages one to four and five to nine.

For example, in Sri Lanka, with the decline in the overall mortality levels, the female death rates in the older reproductive ages 30-44 were brought down first, followed by reduction in the younger reproductive ages 20-29 and only later in childhood ages one to 14. The ratio of age specific death rates of males and that of females for Sri Lanka between 1950-52, 1970-74 and for 1981 is given in Figure 4. In a society where there is absolutely no

Fig. 4. Relative Risk of Dying for Females to Males of Five Year Age Groups, Sri Lanka 1952-54, 1970-72 and 1981



bias in the health care practices and the nutrition of males and females, it is observed that the age specific death rates of females are consistently lower than those of males in every age group. This lower death rate of females at every age is mostly attributable to biological differences, wherein men run the risk of higher mortality at every age from conception. The higher death rate for females compared to males in a society can be attributed partly to the higher levels of mortality prevailing in the society which exposed women in reproductive ages to higher death rates due to maternal causes and partly to lower status of women in the society, which exposed young girls below 15 and young mothers below 29 to the higher risk of mortality largely attributed to neglect of female children,nutritional deficiencies and lack of proper medical care for females as compared to male children. There are many empirical findings from field studies done in India to reveal the neglect of female children and discrimination against them in the matters of nutrition and health care.

A study conducted by C. Gopalan revealed that the percentage of second and third degree malnutrition cases was higher in female children as compared to male children in all the three metropolitan cities of Bombay, Calcutta and Madras[8]. The details can be observed in Table 17. In a study of two villages in West Bengal, it was found that girls consistently had poorer nutritional status than boys in all socio-economic strata as determined by land holding and mother's education[15]. Monica Das Gupta, while stating that it is difficult to quantify the neglect factor, had found evidence of differential care of boys and girls in her study in Khanna (Punjab) during 1984-85. She found that sex differential in allocation of food and medical care mostly occurred in the first two years of life — the most vulnerable period for child survival[4]. She also observed that expenditure on clothing was greater for boys than for girls at all ages. Her study in Khanna in 1985-86 suggests that sex differentials in medical care might be more important in accounting for sex differentials in mortality.

The most striking finding of the 1984 Khanna study of Das Gupta is that the sex bias was not generalised but based on higher birth order girls. The burden of excess mortality falls on those girls who are born into a family that already has a surviving daughter. Thus the study reveals that the neglect is applied selectively to higher order daughters[4] . Such an observation was also made in the report of the 1901 census[12].

Another very important finding of the Khanna study done in 1984 was that sex differentials in mortality had persisted even in the context of socio-economic development and declines in mortality and fertility. Besides, stronger discrimination against girls of higher birth order was observed more among educated women[4] . It must be noted that from all studies it was observed that women, not men, and often the mother herself, who was in charge of distributing food, had indulged in the discrimination against girls.

The conditions in the south are relatively better. As pointed out by Dyson and Moore (1980), the women in South India enjoy more autonomy — "ability — technical, social and psychological — to obtain information and to use it as the basis for making decisions about one's private concerns and those of one's intimates"[6] . However, it should be emphasised that in the global perspective Indian women, on the whole, have only low autonomy. The north-south dichotomy in female autonomy is purely relative[6] .

This lower status of women in India can be attributed mainly to the preference for sons perpetuated in the society. Such a son preference has its roots in religious, cultural and various social institutions of the country, as can be noted from the following observations:

• It was a common practice in Western and Southern India to bless a girl at the time of marriage or a woman with "may you have eight sons and may your husband outlive you". The numerous KAP studies (studies of knowledge, attitude and practice with respect to family size desires and planning) conducted all over India have indicated strong preference for sons by parents. The second all India survey on family planning practices in India conducted in 1980-81 indicates that for a large percentage of couples the best combination of children was two sons and one daughter[13]. The desire for a son was so strong among the Rajputs that if a boy was born in the family it was customary to announce his birth with music, happy songs, and distribution of sweets. If a daughter was born the father would announce 'nothing' has been born, by which expression it would be understood that a girl was born and that she was very likely to be 'nothing'[14].

• It is also this strong preference for sons and dislike of girls which was behind the practice of female infanticide. Again it is the desire to have at least one son which drives, in modern times, the pregnant woman to undergo amniocentesis test and abort the foetus if, unfortunately, it is a girl. In the olden times, it has been reported that pregnant mothers who had only girls used to resort to many utterly superstitious practices "to convert the unborn child into a boy, if unhappily it be a girl"[14]; important among such practices were: procure the rosaries used by mothers of sons for praying and use them for the same purpose, swallow the herbs and roots which are known for their virtue of generating male foetus, worship of trees or son-giving gods. There also existed a ceremony named sacrament, which was carried out in the third or fourth month of pregnancy for the purpose of converting the embryo into a boy[14]. With improvements in technology the old cultural values are only perpetuated more efficiently.

• It has been hypothesised that the fundamental cause for subordination of women in the society is the patriarchal, patrilineal family system, in which men possess a greater degree of power and economic privilege, and the line of descent is through male children. It is seen that strong gender inequalities have coexisted with the patriarchal family system. The patriarchal family system of China, existing for centuries, has given rise to the practice of placing a high premium on sons and discrimination against daughters[7]. Similarly, the effects of secondary status accorded to Chinese women, in their society, are also seen in the recorded practices of female infanticide and tying of the feet of female children from early childhood, and child marriages.

In the patriarchal and patrilineal family system the daughters are considered as "temporary or transitory" members of the family. They are treated as the property of others — to whom they will be given in marriage. The

daughters who are not the members of the descent line have no rights to property (this deep rooted thinking still persists despite the Hindu Code Bill). As a compensation, some dowry is given to the in-laws at the time of marriage. This dowry system has contributed a lot to the dislike of daughters by the parents. According to anthropologist Barbara Miller, "Pride and Purse" are the two important factors leading to female infanticide[11] and discrimination against girls. Both economic and cultural factors are at work in according discriminatory treatment to female children.

Programmes for improvement of status of women in society require not only legislative measures and governmental interventions to prevent such discriminatory practices, but also large-scale social movements by religious and social leaders preaching and campaigning against the discriminatory practices on theological, moral and ethical grounds. Some of the major social, cultural and economic bases of discriminatory practices against females in the society at different stages of family life cycle, and some of the policy and programme interventions that can be implemented to counter such practices are given in Table 18. The suggestions made should be considered as illustrative of the directions of social action necessary rather than specific programme recommendations.

Table 1

Total Population, Total Female Population and Sex Ratio (Females to 1000 Males) in Countries Having 100 Million or more Population (Circa 1981) and Other Countries in the Subcontinent

Country	Year	Total Population	Female Population	Sex Ratio by Age			
				All ages	0-14	15-64	65+
India	1981	685,159,000	330,774,700	933	938	928	965
China	1982	1,003,913,156	488,636,015	948	940	932	1253
U.S.A.	1985	238,740,000	122,579,000	1055	951	1028	1475
Indonesia	1984	161,631,700	81,185,700	1009	966	1030	1200
Japan	1984	120,235,358	61,080,338	1033	950	1013	1422
U.S.S.R.	1973	249,405,500	133,851,300	1158	962	1091	2133
Bangladesh	1981	90,457,000	43,857,000	941	976	876	837
Pakistan	1981	84,253,644	40,020,967	905	935	894	740
Sri Lanka	1984	15,599,000	7,648,000	962	960	968	896
Nepal	1985	16,625,312	8,082,393	946	920	969	903

Source: *(i) Census of India 1981, Series 1 India, Paper 1 of 1984, Population Projections for India 1981-2001. p. 12.*

(ii) The United Nations Demographic Year Book 1985 United Nations, pp. 188-189, 192-197.

(iii) The United Nations Demographic Year Book 1982 United Nations, pp. 208-209

Table 2

Sex Ratio in India, 1901-2001 (Females per 1000 Males)

Census	Sex Ratio
1901	972
1911	964
1921	953
1931	950
1941	945
1951	946
1961	941
1971	930
1981	933
1986*	937
1991*	940
1996*	942
2001*	944

** Sex ratio of projected population, medium variant.*

Sources: (1) Up to 1981, Department of Family Welfare, Ministry of Health and Family Welfare, Government of India, New Delhi, India's Population: Demographic Scenario, August 1987, p. 2.

(2) Census of India, 1981, Series 1, India, Part I of 1984, Population Projection for India, 1981-2001, pp. 12-13.

Table 3

Sex Ratio by Five-year Age Groups for India, China and the United States of America, Circa 1981

Age Group	India 1981	China 1982	U.S.A. 1985
< 1	959	929	953
1-4		934	954
5-9	944	942	954
10-14	909	943	952
15-19	912	965	964
20-24	947	963	997
25-29	969	938	998
30-34	962	923	1007
35-39	941	898	1026
40-44	913	875	1040
45-49	885	891	1051
50-54	876	895	1072
55-59	898	937	1112
60-64	939	995	1148
65-69	958	1090	1217
70-74		1229	1355
75-79		1464	1573
80-84	978	1743	1889
85+		2242	2507
All ages	933	948	1055

Sources: 1. The United Nations Demographic Year Book, 1985.

2. Registrar General and Census Commissioner India, Census of India, 1981, Series 1, India paper 5 of 1984, Age Tables based on 5 percent sample data, p. 53.

Table 4

Age-sex Specific Death Rates and Difference in Male and Female Death Rate for India 1976-80 (Rural), and the United States of America, 1983

	India 1976-80 (Rural)			U.S.A., 1983		
	Age Specific Death Rate per 1000			Age Specific Death Rate per 1000		
Age (1)	Male (2)	Female (3)	Difference (4)=(2)–(3)	Male (5)	Female (6)	Difference (7)=(5)–(6)
–1	49.6	55.0	–5.4	12.3	9.2	3.1
1-4				0.6	0.5	0.1
5-9	4.1	5.1	–1.0			
10-14	2.1	2.1	0.0	0.3	0.2	0.1
15-19	2.3	3.2	–0.9			
20-24	2.9	4.4	–1.5	1.4	0.5	0.9
25-29	3.0	4.8	–1.8			
30-34	4.0	4.5	–0.5	1.7	0.7	1.0
35-39	5.3	5.1	+0.2			
40-44	8.2	6.2	+2.0	2.7	1.4	1.4
45-49	10.9	7.9	+3.0			
50-54	17.4	12.4	+5.0	7.0	3.9	3.1
55-59	26.4	19.2	+7.2	14.0	7.4	6.6
60-64	41.6	32.7	+8.9	20.8	11.2	9.6
65-69	56.3	47.0	+9.0	32.0	16.9	15.1
70-74				48.6	25.4	23.2
75-79	106.3	92.5	+13.8	72.1	40.5	31.6
80-84				106.3	66.0	40.3
85+				184.0	141.9	42.1
All ages	–	–	–	9.4	7.8	1.6

Source: (1) Sample Registration System, 1979-80, p. 36.
(2) The United Nations Demographic Year Book, 1985, pp. 642-643.

Table 5

Sex Ratios by Five-year Age Group for Various States in India, 1981

Age	Northern Zone			Eastern Zone			Central Zone		Southern Zone				Western Zone		All
	Punjab	Hary-ana	Raja-sthan	Bihar	Orissa	West Bengal	M.P	U.P.	Tamil Nadu	A.P	Kerala	Karn-ataka	Guja-rat	Maha-rashtra	India
0-4	899	939	944	1000	1000	1011	963	912	966	976	967	988	964	973	959
5-9	885	889	935	939	1005	967	982	874	972	994	981	992	932	940	944
10-14	896	853	921	923	992	961	920	848	978	959	1018	967	928	917	909
15-19	893	839	907	887	977	926	868	825	996	967	981	939	932	897	912
20-24	884	851	909	865	972	890	886	889	1018	937	1017	961	962	917	947
25-29	857	877	898	914	982	875	903	965	1024	992	1103	970	958	950	969
30-34	867	840	901	1031	985	863	914	969	1023	1016	1118	972	938	958	962
35-39	908	907	905	1093	973	839	927	953	999	1027	1059	959	926	947	941
40-44	918	921	903	1031	943	808	933	915	956	1005	1057	947	921	927	913
45-49	911	922	912	945	908	791	930	866	917	983	1036	911	897	908	885
50-54	894	832	909	889	895	788	942	834	910	901	1025	898	889	896	876
55-59	847	817	881	874	925	817	991	835	910	874	1052	914	945	911	898
60-64	805	752	882	908	990	886	1085	859	925	934	1064	910	1007	961	939
65-69	752	708	943	949	1087	961	1256	837	943	1010	1125	934	996	1019	958
70+	745	678	1023	922	1104	1062	1116	804	949	1043	1234	1046	1033	1058	978
All ages	879	870	919	946	981	911	941	885	977	975	1032	963	942	937	934

Source: Sex ratios computed from the smoothed data. Census of India 1981, Series-1 India, Paper 5 of 1984. Age Tables based on 5 percent sample data pp. 53-54.

Table 6

Trends in Sex Ratios (Females to 1000 Males) in Different Ages by Geographic Zones

Age	India			Eastern Zone			Central Zone			Southern Zone			Western Zone			Northern Zone		
	1901	1951	1981	1901	1951	1981	1901	1951	1981	1901	1951	1981	1901	1951	1981	1901	1951	1981
0-4	1032	992	959	1067	1012	1004	1004	990	927	1053	1004	975	1053	982	970	946	939	932
5-9	960	968	944	977	963	960	922	946	907	1001	1013	986	979	973	937	893	919	914
10-14	832	909	909	828	900	948	806	868	871	887	974	975	841	907	921	778	869	900
15-19	908	940	912	1005	963	917	849	904	839	941	958	971	920	916	910	793	900	889
20-24	1092	1025	947	1152	1008	892	1038	1009	888	1198	1077	980	1081	1016	933	937	978	890
25-29	988	953	969	1017	921	910	963	915	943	1066	1036	1014	959	942	953	877	938	882
30-34	985	958	962	1001	930	957	951	939	950	1067	1037	1023	962	931	951	901	922	890
35-39	907	874	941	931	872	972	942	854	944	875	925	1008	901	850	940	849	836	906
40-44	985	900	913	1003	873	928	989	886	921	992	954	984	989	902	925	931	860	911
45-49	898	849	885	930	854	880	937	856	885	860	860	954	906	854	904	817	771	913
50-54	1013	924	876	1061	921	853	1012	887	865	1029	1008	921	1018	922	894	902	803	900
55-59	933	861	898	1051	914	863	966	842	879	877	899	919	919	817	922	770	729	859
60+	1192	1028	958	1354	1044	964	1204	1083	915	1159	1039	996	1218	1159	1012	932	777	832
Total	972	946	933	1010	945	939	951	926	902	1006	994	981	970	944	939	874	886	898

Source: 1. *S.B. Mukherjee, The Age Distribution of Indian Population, A Reconstruction for The States and Union Territories, 1881-1961, Honolulu: East-West Population Centre, 1976.*

2. *Census of India 1981, Series 1, India, Paper 5 of 1984. Age tables on 5 percent sample data, pp. 53-54.*

Table 7

Sex Ratio for Different Religious Communities in India for 1901, 1951, 1981

Religion	India		
	1901	1951	1981
Hindus	971	949	933
Muslims	939	938	937
Christians	939	992	992
Sikhs	767	851	880
Jains	928	927	942
Buddhists	948	917	953
Jews	995	824	NA
Parsis	959	991	NA
All religions	972	946	933

NA: Not Available

Sources: 1. *Census of India, 1901, Vol. II, Tables*
2. *Census of India, 1951, Paper No. 1 of 1959, Religion & livelihood classes of re-organised states, 1951, R.G. Office, New Delhi, pp. 7-8*
3. *Census of India, 1981, Series 1, India, Paper 4 of 1984, Household population by religion of head of household, pp. 2-7*

Table 8

Sex Ratio by Caste, India, 1931 (Females per 1000 males)

Caste or Tribe	Sex Ratio
Rajput (Rajputana)	798
Jat	805
Gujjar	832
Brahman (Bengal)	847
Rajput (India)	868
Sayyid	884
Kayastha	888
Momin	898
Brahmin	902
Gadaria	929
Kunbi	937
Komti	938
Yadav	948
Dom	952
Chamar	967
Teli	979
Mahar	1001
Maratha	1004
Sawara	1019
Gond	1045
Nayar (India)	1049
Tanti	1058
Nayar (Cochin)	1154

Source: Census of India, 1931, Vol. 1, Delhi: Gian Publishing House, 1986, p. 204.

Table 9

Infant Mortality Rates by Sex in India and Major States, 1973 & 1984

	1973			1984		
	M	F	Relative Risk (F/M)	M	F	Relative Risk (F/M)
India	132	135	1.02	104	104	1.00
Andhra Pradesh	108	101	0.94	83	72	0.86
Assam	142	131	0.92	101	96	0.95
Bihar	–	–	–	94	96	1.02
Gujarat	155	168	1.08	105	106	1.01
Haryana	100	108	1.08	92	112	1.22
Himachal Pradesh	86	86	1.00	97	83	0.86
Jammu & Kashmir	66	64	0.97	73	82	1.12
Karnataka	94	86	0.91	77	70	0.91
Kerala	58	50	0.86	34	23	0.68
Madhya Pradesh	138	153	1.01	125	116	0.93
Maharashtra	118	114	0.97	77	75	0.97
Orissa	158	133	0.84	132	130	0.98
Punjab	106	123	1.16	66	67	1.01
Rajasthan	130	146	1.12	118	127	1.08
Tamil Nadu	115	100	0.87	79	77	0.97
Uttar Pradesh	169	186	1.10	150	160	1.07
West Bengal	104	71	0.71	85	78	0.88(urban)

Source: (1) Vital Statistics Division, Office of the Registrar General of India, Sample Registration System, 1984, p.38.

(2) Vital Statistics Division, Office of the Registrar General of India, Sample Registration Bulletin, Vol.XII, No.2, December 1978, pp. 19-21.

Table 10

Neonatal and Post-neonatal Mortality by Sex for India, Sri Lanka, Pakistan and Bangladesh

	Male	Female	Relative Risk (F/M)
1. SRS Rural 1968			
Mortality Rate by Age:			
Below 7 days	46.0	40.4	0.878
7 to 28 days	33.4	27.9	0.835
29 days to 6 months	35.7	42.5	1.190
7 to 12 months	20.9	26.9	1.287
Infant mortality rate	136.0	137.7	1.013
2. Kadhipur Primary Health Centre, Sultanpur Dist., U.P. 1974-77			
Neonatal mortality rate	86	80	0.930
Post-neonatal mortality rate	46	73	1.587
Infant mortality rate	132	153	1.159
3. Khanna, 1965-84			
Neonatal mortality rate	50.7	43.0	0.848
Post-neonatal mortality rate	27.1	51.3	1.893
Infant mortality rate	77.7	94.3	1.214
4. Matlab: Bangladesh 1974-77			
Neonatal mortality rate	78.2	67.6	0.864
Post-neonatal mortality rate	52.6	63.9	1.215
Infant mortality rate	130.9	131.5	1.005
5. Pakistan, 1979			
Under 1 day	1.6	1.3	0.812
1-6 days	28.9	19.5	0.675
7-27 days	25.4	21.1	0.831
28 days-5 months	33.7	32.8	0.973
6-11 months	11.2	13.5	1.205
Infant mortality rate	100.7	88.1	0.875

Continued overleaf

Table 10 contd.

	Male	Female	Relative Risk (F/M)
6. Sri Lanka, 1981			
1-6 days	14.9	12.4	0.832
7-27 days	5.8	4.8	0.828
28 days-5 months	6.9	6.2	0.899
6-11 months	4.0	3.9	0.975
Infant mortality rate	31.6	27.3	0.864

Sources: 1. *V.K. Ramabhadran and V.S. Swamy, "Measures from Indian Sample Registration System", in K.E. Vaidyanathan (Ed.), Studies on mortality in India, Gandhigram: The Gandhigram Institute of Rural Health and Family Planning, 1972, p.46.*

2. *V.K. Srivastava, A Study of Sex-selective Factors of Post-neonatal Mortality, Dept. of Statistics, Lucknow University, Lucknow, 1979, p. 9 (Mimeographed).*

3. *Lincoln, Chen et. al., "Sex Bias in the Family Allocation of Food and Health Care in Rural Bangladesh", Population and Development Review Vol. 7, No. 1, March 1981, p. 56.*

4. *Monica Das Gupta, "Selective Discrimination against Female Children in Rural Punjab, India", Population and Development Review, Vol. 13, No. 1, March 1987, p. 81.,*

For 5 and 6, The United Nations Demographic Year Book 1985, p. 478.

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Table 11

Relative Risk of Female to Male Mortality in Childhood Age Groups for Rural, Urban and Combined Areas, India and States, 1984

States	Age Groups								
	0-4			5-9			10-14		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
India	1.09	1.05	1.09	1.29	1.31	1.28	1.29	1.08	1.25
Andhra Pradesh	0.90	1.04	0.93	1.00	1.00	1.00	1.47	1.73	1.57
Assam	0.93	0.78	0.92	0.77	1.56	0.80	1.19	–	1.06
Bihar	1.12	1.41	1.14	1.60	1.92	1.60	1.14	3.00	1.20
Gujarat	1.03	1.22	1.06	1.30	7.00	1.12	1.13	0.75	0.89
Haryana	1.37	1.29	1.36	1.33	0.49	1.07	1.43	1.13	1.33
Himachal Pradesh	0.99	1.87	0.99	0.74	2.80	0.81	–	–	0.17
Jammu & Kashmir	1.06	0.98	1.05	1.10	5.00	1.33	1.27	–	1.33
Karnataka	1.00	1.16	1.03	1.14	1.00	1.10	1.18	0.70	1.07
Kerala	0.70	0.73	0.71	0.83	0.80	0.82	1.67	–	1.80
Madhya Pradesh	1.03	0.98	1.02	1.32	3.20	1.38	0.70	1.00	0.74
Maharashtra	1.05	0.84	1.00	0.93	0.50	0.90	0.56	0.75	0.60
Orissa	1.03	1.15	1.04	1.31	2.71	1.35	1.06	0.56	1.00
Punjab	1.17	1.02	1.15	0.96	3.50	1.11	1.13	0.77	1.07
Rajasthan	1.15	1.02	1.13	1.38	1.46	1.39	1.00	2.25	1.09
Tamil Nadu	1.07	1.01	1.06	1.19	1.25	1.24	1.20	0.67	1.15
Uttar Pradesh	1.19	1.11	1.18	1.51	1.28	1.48	2.06	1.00	1.77
West Bengal	1.08	0.85	1.05	1.07	1.35	1.14	1.63	1.43	1.57

Source: Vital Statistics Division, Registrar General, India, Ministry of Home Affairs, Sample Registration System 1984, New Delhi 1987, Table 4.

Table 12

Percentage Distribution of Districts by Differentials in Male and Female Child Mortality, 1981

	$_2q_0$	$_3q_0$	$_5q_0$
1) Female mortality> than male mortality	35.3	42.8	55.7
2) Female mortality< than male mortality	61.9	54.0	41.8
3) Female mortality equal to male mortality	2.8	3.2	2.5
All districts	100.0	100.0	100.0
No. of districts	402	402	402

Source: Census of India, 1981, Occasional Papers No. 5 of 1988, Child Mortality Estimates of India, Statement 1.9, p.17.

Table 13

Relative Risk of Female to Male Mortality Rates in Age Groups 15-49 for India and States, 1984

States	Age Groups						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
India	1.40	1.39	1.36	1.09	0.96	0.82	0.65
Andhra Pradesh	2.18	1.08	1.00	1.08	0.78	0.95	0.76
Assam	1.56	1.23	1.92	1.64	1.31	1.14	0.74
Bihar	1.41	1.31	1.74	1.18	1.80	1.04	0.65
Gujarat	1.00	0.94	1.03	0.97	0.92	0.59	0.51
Haryana	1.23	1.63	1.27	1.59	1.71	0.92	0.76
Himachal Pradesh	1.00	2.00	0.71	0.55	0.67	0.55	0.73
Jammu & Kashmir	1.44	1.86	1.70	1.16	0.84	1.04	0.34
Karnataka	2.30	1.68	1.37	0.89	0.57	0.79	0.52
Kerala	0.33	0.69	0.74	0.44	0.48	0.26	0.55
Madhya Pradesh	1.55	1.46	1.03	0.80	1.42	0.53	0.83
Maharashtra	1.71	1.12	1.30	1.32	0.60	0.77	0.59
Orissa	0.67	1.86	1.40	1.47	0.80	0.73	0.78
Punjab	1.28	1.12	1.43	1.14	0.42	0.47	0.39
Rajasthan	2.42	1.00	1.36	0.67	1.17	0.65	0.63
Tamil Nadu	1.04	1.11	0.93	1.09	0.62	0.60	0.52
Uttar Pradesh	1.56	1.94	2.10	1.48	1.06	1.04	0.70
West Bengal	1.57	1.48	1.70	1.26	0.79	0.71	0.93

Source: Same as that for Table 11.

Table 14

Age Specific Death Rates for Broad Age Groups for Males and Females and Relative Risk of Dying for Females to Males, India Rural, 1981, 1986

Age Groups	1981			1986		
	Male	Female	Relative Risk	Male	Female	Relative Risk
0-4	39.2	43.3	1.10	34.7	38.6	1.11
5-14	2.7	3.1	1.15	2.19	2.68	1.22
15-34	2.5	3.6	1.44	2.45	3.22	1.31
35-49	6.7	5.5	0.82	6.56	4.74	0.72
50 +	37.8	32.8	0.87	35.03	30.3	0.86

Source: Sample Registration System 1981 and Sample Registration System 1986, Vital Statistics Division, Office of the Registrar General, India.

Table 15

Expectation of Life at Birth for Males and Females, India, 1941-2001

Period	Males	Females
1941-51	32.5	31.7
1951-61	41.9	40.6
1961-71	46.4	44.7
1971-81	50.9*	50.0*
	51.2**	51.2**
	52.5***	52.9***
1981	54.1	54.7
2001	64.1	65.6 +

**Based on Sample Registration System*

***Based on forward survival method using South Asian model and unsmoothed data of 1971 and 1981 censuses*

****Based on Preston and Bennett technique using unsmoothed age data of 1971 and 1981 censuses.*

Source: Census of India, 1981, Series-I, India, Paper 1 of 1984, Population Projections for India 1981-2001, pp.23-24.

+ Census of India, 1981, Occasional Papers No. 4 of 1988 Report of the Expert Committee on Population Projections, Demography Division, Office of the Registrar General of India, New Delhi, 1988.

Table 16

Selected Social Indicators of Status of Women for Major States of India, 1981

Name of the State (1)	Sex Ratio (2)	Sex Ratio in the age group (0-9) Females/ 1000 Males (3)	Literacy Ratio (FLR/MLR * 100) (4)	Employment Ratio (5)	School Enrolment Ratio (6)	P_F/P_M * 100 (7)	Composite Index Cols. (3+6+7)÷ 3 (8)
Andhra Pradesh	975	995	51.94	22.01	(2) 63.24	101.80	(3) 88.2
Bihar	946	967	35.74	9.91	(1) 43.14	99.10	(2) 79.6
Gujarat	942	943	59.33	10.57	(3) 67.02	99.33	(3) 86.9
Haryana	870	896	46.20	7.14	(1) 49.94	97.76	(2) 79.1
Himachal Pradesh	973	969	59.15	8.54	(3) 69.67	102.31	(3) 89.6
Jammu & Kashmir	892	962	43.76	9.52	(2) 54.48	99.67	(2)83.5
Karnataka	963	989	56.77	23.30	(3) 69.92	101.01	(3) 89.9
Kerala	1032	974	87.34	26.40	(4) 95.52	100.96	(4) 98.0
Madhya Pradesh	941	974	39.33	18.88	(1) 47.22	100.72	(2) 81.8
Maharashtra	937	964	59.18	15.53	(3) 71.59	101.59	(3) 89.9
Orissa	981	1005	44.84	16.20	(2) 61.32	100.82	(3) 87.5
Punjab	879	900	71.44	7.34	(3) 74.19	99.12	(3) 87.8
Rajasthan	919	947	31.46	10.18	(1) 33.06	100.35	(2) 76.0

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Table 16 contd.

Name of the State (1)	Sex Ratio (2)	Sex Ratio in the age group (0-9) Females/ 1000 Males (3)	Literacy Ratio (FLR/MLR * 100) (4)	Employment Ratio (5)	School Enrolment Ratio (6)	P_F/P_M * 100 (7)	Composite Index Cols. (3+6+7)÷ 3 (8)
Tamil Nadu	977	972	60.06	21.03	(3) 74.24	101.57	(3) 91.0
Uttar Pradesh	885	913	36.22	6.82	(1) 39.75	98.48	(2) 76.5
West Bengal	911	979	59.70	11.87	(3) 73.46	100.89	(3) 90.8
India	933	958	52.93	14.81	60.41	100.57	85.6

Sources: (1) Census of India 1981 (Various States), Part II-B, Primary Census Abstract.
(2) Census of India 1981 (Various States), Part IV-A, Socio-Cultural Tables.
(3) Census of India 1981, Occasional Paper No.5 of 1988, Child Mortality Estimates of India.

For India: 1. Census of India 1981, Series I – India, Part IV-A, Social & Cultural Tables, pp. 304-369, 400-443, 656-677.
2. Family Welfare Programme in India, Year Book 1983-84, p.33.
3. Census of India 1981, Series 1 – Part II (B) (i), Primary Census Abstract, General Population, pp. xlvi liv.
4. Census of India 1981, Occasional Paper No.5 of 1988, Child Mortality Estimates of India, p.5.

Table 17

Malnutrition on the Gomez' Scale in Male and Female Infants

Centre	Male							Female						
		Retardation Grade							Retardation Grade					
	Excel-lent	Normal	I	II	III	NR	N	Excel-lent	Normal	I	II	III	NR	N
Bombay	12.5	21.9	42.5	18.3	2.8	2.0	958	8.2	17.4	43.2	25.4	4.5	1.3	862
Calcutta	5.4	14.2	42.7	25.0	8.2	4.5	667	5.5	14.8	36.9	27.5	10.6	4.7	710
Madras	10.2	19.9	41.7	23.0	3.1	2.1	846	5.6	14.8	43.8	28.3	5.7	1.8	883

N = Total number of sample. NR = No response.

Source: C. Gopalan, The Mother and Child in India, Economic and Political Weekly, Vol. 20, No.4, January 26, 1985, p.162.

Table 18
Factors Underlying Low Status of Females in Their Life Cycle and the Possible Remedical Measures

Age	Underlying factors for low status of females	Indicated remedial measures – Policy and programmes
Before birth female foeticide based on sex determination by amniocentesis	Preference for sons; fear of dowry and dowry related suffering for the daughter. Increased economic and social burden when the parents have a female child already.	Legal ban on the tests for sex determination pregnancy. Education for the parents to give equal value to sons and daughters.
Post-nenatal and childhood period 1 month to 5 years	Greater neglect on immunisation for female children: malnutrition, lesser health care and attention at the time of illness for female children resulting in higher morbidity and mortality rates for female children.	Monitor immunisations especially for female children. Wherever possible introduce creches for care of preschool children including feeding at the community level. The above can be considered as a part of the ICDS programme.
Age 5-14 (pre-adolescence)	Higher morbidity and mortality of girls are attributed to: 1) deficiency in school enrolment of female children, 2) higher discontinuation rates for female children, 3) Placing greater responsibilities at home on the female child for care of siblings, cooking & other activities 4) Child marriages in rural areas, 5) Female child labour.	1) Strict implementation of compulsory schooling up to the age of 14. 2) Mid-day meal programme for school children up to age 14, 3) Comprehensive schoold health programme, 4) Education of parents on the importance of female education. 5) Implementation of Minimum Age at Marriage Act, 6) Sex and family life education at school.
15-19 (late teens)	Many girls get married and start child bearing. Malnutrition. Lack of additional nutritional support during pregnancy. Unhygienic materinal care. Hard wc rk at parental home and in-law's place. Dowrty death.	1) Strict implementation of Maximum Age at Marriage Act of 18 for girls. 2) Wherever girls cannot continue schooling, to provide for economically gainful activities near the place of their residence. 3) Adult Education Programmes for women on alternatives to marriage and motherhood. 4) Demystifying the glories and virtues of monther-hood by under taking empirical studies on the nature of relationship between mothers and children. 5) Active propaganda and legal action to prevent any form of dowry.

Continued overleaf

Table 18 contd.

Age	Underlying factors for low status of females	Indicated remedial measures – Policy and programmes
20-34 too frequently born.	Early reproductive periods for women with increased maternal depletion, morbidity, due to too many children Poor antenatal, natal and postnatal care, greater share of the economic and family burdens culturally expected of her.	Organised maternal and child health care. Family Planning Programme for provision of spacing and terminal methods. Special incentives to parents who limit with one or two daughters. Propaganda on the equality of sexes. Innovative programmes to provide income-generating activities event to young women with families, through adoption of community kitchen, creches, etc. Adult Education Programmes.

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Nutrient Requirements And RDA For Girls And Women

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The human being needs a wide range of nutrients to keep him healthy and active and he must derive most of these nutrients through his daily diet. Several of these nutrients are known to be quite essential since deficiencies due to inadequate intake of these nutrients are often encountered in the human subject. These are energy, protein, calcium, iron, fat soluble vitamins — vitamin A and vitamin D — and water soluble vitamins — ascorbic acid and B-complex vitamins:thiamin, riboflavin, nicotinic acid, pyridoxine, folic acid and vitamin B_{12}. The major nutrients like energy (carbohydrates and fats), protein and minerals like calcium and iron are essential for growth and maintenance of the integrity of the body tissues. The other nutrients namely vitamins and trace minerals are required for the metabolism of these major nutrients and to maintain tissues at an optimum level of activity. Besides the above nutrients, there are also other nutrients like several trace metals and other vitamins which are known to be required, but deficiencies attributed to these nutrients are however not commonly encountered. These nutrients may be present in adequate amounts to satisfy human needs in habitual diets otherwise adequate with regard to the above mentioned nutrients. Studies carried out over the past several decades have established the quantitative requirement of these nutrients. The dietary requirements of these nutrients depend upon the age, sex and the quality of man's habitual diets.

Nutrient Requirements – Age, Sex Differences

Human nutritional requirements are dependent on age and sex. The requirement of nutrients by infants and children are relatively greater than adults. In early childhood the requirement when expressed as per kg body weight may be two or three times the adult requirement. This is because the

nutrient requirement during infancy and childhood should meet the maintenance as well as the growth requirements while during adulthood requirement is only for maintenance. The requirement of the child is proportional to his growth rate, the growth rate being highest in early infancy and gradually declining with age. The nutritional requirements per kg body weight is therefore highest in early infancy and it gradually declines to a constant adult value by the age of 20, but with a small increase during the adolescent growth spurt between 12 and 16 years of age.

The nutritional requirements of females also follow the same pattern as in males, but they differ from males in certain important respects during certain age periods. There is not much difference between men and women in nutritional requirements during infancy and early childhood. During adolescent and adult periods, however, the nutrient requirements of women are lower than men, since the growth rate during adolescence and the adult body weight attained are lower in women than in men. During the reproductive age period, due to blood loss during the menstrual period, women's need for certain nutrients concerned with blood formation (viz. iron, folate, and vitamin B_{12}) is much higher than in men. To compensate for the higher requirement, however, the utilisation of nutrients like iron (absorption) is nearly twice in women as compared to men.

Approaches For Assessing The Human Nutrient Requirements

Although measurement of dietary intakes of healthy and well nourished individuals can provide a rough guideline for the nutrient requirements, this approach often over-estimates the requirements, and the physiological requirement of nutrients cannot be estimated from dietary intake data. However, this approach is often used for estimating the energy requirement of infants and young children among whom direct determination of nutrient requirement is often difficult. Our present knowledge of human requirement of several nutrients is based on experimental studies in healthy human volunteers. Most of these studies have been carried out with men volunteers and studies with women volunteers are limited. However, basic data obtained in men and boys are often used to arrive at the requirement of women and girls after making allowances for their lower BMR and lower body weights. Balance studies are often used to arrive at the minimal requirement of nutrients by feeding diets containing different levels of the nutrients and finding out the amount retained in the body. For adults the minimum level of intake that results in zero balance (maintenance) is taken as the requirement while during the growing period, a positive nutrient balance consistent with satisfactory growth rate is taken as their minimal requirement. This approach has been widely used for assessing the requirement of protein.

Another widely employed approach is the so-called factorial method in which metabolic or obligatory loss of nutrients through urine, faeces and skin are determined to obtain the maintenance requirement of nutrients for the adult. This amount of nutrient must be ingested daily through diet to compensate for the obligatory losses of the nutrient. However, for growing infants and children, the growth component has to be added. Growth requirement is computed from the growth increment of body tissue and their nutrient composition. Thus, requirement (R) is the sum of nutrient loss through urine (U), faeces (F) and skin (S) and that required for growth (G).

$$R = U + F + S + G$$

The basal losses of nutrients are related to basal metabolism and can be computed for any individual from his basal metabolism rate (BMR). Since the BMRs in females are generally lower than in males,the computed values for nutrient requirements of women and girls will be correspondingly lower.

Nutrient requirements have also been determined by studying their turnover in the body, employing radio-isotopically labelled nutrients. This approach has the advantage of providing information on nutrient loss even under normal conditions of dietary intake. The turnover of iron, trace elements, vitamins like B_{12}, vitamin A, ascorbic acid have been determined in men to establish their requirement. However, the use of radioactive labelled compounds has certain limitations because of associated radiation hazards and hence it cannot be used in children and women and particularly during pregnancy and lactation. Hence, most of the turnover studies have been done in men and the same values are used for computing requirements of females also. In recent years, stable isotopes for this purpose are coming to be used increasingly[45]. Stable isotopes can be used safely both in children and women. Hopefully, more basic data on nutrient requirements of women will be available in future, based on the use of stable isotopes.

Another approach to determine the human requirement of vitamins is based on tissue saturation of the vitamin or its coenzymes. This approach has been used for assessing the requirement of ascorbic acid and B-complex vitamins.

Nutrient Requirements And RDA

The requirement of a nutrient is defined as the amount of absorbed nutrient that is necessary to fulfil its physiological function in the body. When applied to a group of individuals, it represents the average values for the group. However, in practical nutrition it becomes necessary to define the nutrient requirement in terms of the amount present in the habitual diets consumed by the population and also to indicate the level that would cover the

requirement of most of the individuals in a given population. This is referred to as recommended dietary allowances (RDA). RDA is defined as the nutrient present in the diet that satisfies the requirements of nearly all individuals in a population.

The following factors are therefore considered in arriving at the recommended dietary allowances.

- Physiological requirement of nutrients
- Bioavailability of the nutrient from the habitual diets
- The extent of variation in the requirement between and within individuals in a given population

Thus,

$$\text{RDA} = \frac{\text{Physiological requirement}}{\text{Fraction of the nutrient available from the diet}} \times \text{Safety margin to cover almost all individuals in a population}$$

It often happens that in arriving at RDA certain approximations are employed in the case of certain nutrients. Hence, RDA must be considered as a guideline for a desirable intake of nutrients for maintaining health and body function at an optimum level.

Energy Requirement And Allowance

Energy requirement is primarily related to energy expenditure which,in turn, is dependent on age, body weight and the level of activity. During infancy, childhood and adolescence, energy intake should cover the requirement for growth also. Basal energy expenditure accounts for nearly half of daily energy requirements. The energy requirement for activity is also related to BMR. Currently, energy allowance for adults are based on energy expenditure rather than energy intake. However, during infancy and childhood when activity cannot be easily defined, energy intakes of healthy, normally growing infants and children are generally used to define the energy requirements of these two groups. Some limited data on energy intakes of healthy, normally growing preschool Indian girls are available[33]. Energy intakes of healthy preschool children of well-to-do parents were measured over a period of one year on six occasions. The mean intakes of energy given in Table 1 compare well with the currently recommended values[17].

Energy requirements of adults are computed from their BMR and physical activities in a day and the energy cost of these activities. Some limited data on BMR and energy cost of activities of women and girls are available[7, 8, 42]. Basal metabolic rates of women are generally lower than those of men by about 10 percent and BMR of Indians in general is lower by 10 percent than the values reported for the European population[7, 28]. Since the energy expenditure is generally related to basal metabolism, the current trend has been to express the 24 hour allowances for energy intakes for different categories of activities in terms of BMR values[20]. The ICMR expert committee[17] also has recently adopted the same approach and has suggested the following BMR factors for deriving the energy requirements of Indian women engaged in different levels of activity:

Activity	*BMR factors*
Light	1.55
Moderate	1.78
Heavy	2.10

The BMR for 24 hours can be computed from the body weights using the formula suggested by FAO/WHO (1981)[20]. However, since the BMR of Indians is generally lower, it is suggested that the FAO/WHO equation can be used for computing BMR of Indians, but after lowering the values by five percent[17]. The following formula has been suggested for computing BMR of Indian women.

BMR for 24 hrs = 14.7 x body wt (kg) + 471

The reference body weight for Indian women has been considered to be 50 kg instead of 45 kg suggested by the earlier committees. This corresponds to the expected body weight for the current height of Indian women. In the absence of all-India standard body weights for well-to-do Indian children, National Centre for Health Statistics, U.S.A. (NCHS) standards are used for the time being to compute energy requirements of children and adolescents. The energy requirements recommended by the ICMR 1988 committee[17] for women and girls are given in Table 2.

Protein Requirement And Allowance

Proteins are important for maintaining tissue integrity and function and for growth. Adults require protein for maintenance, that is, to replace the losses of tissue protein that normally occur. During infancy and childhood additional protein is required for growth. Dietary protein requirement depends on (a) digestibility of the dietary protein, and (b) its essential amino acid content. Proteins of egg and milk have essential amino acid composition consistent with human requirement and they are highly digestible. Hence these proteins are completely utilised and they are defined as reference pro-

teins with nutritive value of nearly 100. The protein requirements are therefore defined usually in terms of these reference proteins. However, many dietary proteins, particularly those of vegetable origin, are limited in one or the other of the essential amino acids. For example, cereal proteins are generally deficient in lysine, while proteins from pulses and legumes contain adequate lysine but are deficient in sulphur amino acids. However, a combination of cereals and pulses provides protein of quality better than that of either cereals or pulses. Similarly the quality of cereal proteins can be improved when consumed in combination with milk, fish and other animal foods which are all rich in lysine. An optimum combination of cereals and pulses to yield maximum quality is four parts of cereal protein and one part of pulse protein corresponding to eight parts of cereal and one part pulse[30]. Many habitual diets consumed in India are based on cereals and pulses and have protein quality, i.e. NPU of 65 relative to that of egg protein (NPU 100). Proteins from such diets will not be deficient in lysine unlike proteins from diets exclusively based on cereals. A small amount of animal protein, derived from milk, egg, fish or meat included in a cereal-based diet can also upgrade the nutritive quality of cereals. If the protein requirement is defined in terms of egg protein, as is the current practice, requirement in terms of dietary protein can be computed as follows:

$$\text{Protein requirement in terms of dietary protein} = 100 \times \frac{\text{Protein requirement in terms of egg protein}}{\text{NPU dietary protein relative to egg}}$$

NPU of mixed vegetable proteins present in a well-balanced habitual Indian diet based on cereals and pulses is 65 relative to egg protein[31]. However, NPU of proteins present in ill-balanced diets predominantly based on cereals with little or no pulse will be much lower. It can be as low as 50. Protein intake to meet the requirement on such diets will be 30 percent higher than that on a well-balanced diet because of poorer protein quality.

Requirement And Safe Allowance Of Proteins For Indian Women And Girls

Two N balance studies have been reported, designed to determine the protein requirement of Indian adult women[1,27]. Both studies report almost similar values for the minimum requirement of protein, i.e. 0.5 g/kg in women, which is not substantially different from the value reported for adult men[29]. In one of these studies[27], it was shown that the minimum protein requirement per kg body weight in undernourished women is no way different from that observed in well nourished women. There have been no reported studies on the protein requirement of girls. But protein requirement of preschool male children has been determined[18]. The same figures can be used for female children also. However, an N balance study on adolescent college girls[26] on

their habitual diets indicates that the current RDA is quite adequate to promote satisfactory N retention. Based on the available N balance studies and after making allowances for sweat loss of nitrogen and inter-individual variation, a safe level of intake of 1 g/kg body weight of protein of 65 NPU has been recommended for both adult women and men. For children and adolescent girls protein allowances vary from 2 g/kg in early childhood to a little over 1 g/kg in case of adolescent girls. The recommended intakes of protein are given in Table 2.

Another important point about protein requirement is that the recommended protein intakes are valid only when energy intake is adequate. However, if energy intake falls below requirement, the protein requirement will increase. This relationship has been reported in male adults[35] and in male preschool children[19]. The relationship would presumably apply to females also. A recent study[9] in adolescent girls confirms this relationship. This relationship would presumably operate within a reasonable limit of reduction in energy intake, for example, a reduction in energy intake of preschool children by 30 percent i.e. from 100 kcal/kg/day to 70 kcal/kg/day would require an increase in the intake of protein by 20 percent from 1.75 g/kg to 2.15 g/kg to obtain the same level of N retention[19]. This relationship should be borne in mind while assessing the adequacy of dietary protein when energy intake is inadequate. A diet with 7 protein energy % can meet protein needs of a preschool child adequately. However, on a 30 percent lower energy intake the diet should have 10 protein energy % to meet the protein needs.

Mineral Requirement – Calcium, Phosphorus And Trace Minerals

The minerals which are considered important for determining their requirement and for making dietary allowances are calcium and phosphorus. Although the body needs other minerals like sodium, potassium and magnesium, no definitive recommendations can be made for lack of precise information on their requirement by Indians. Calcium and phosphorus are required for bone formation and calcium in the form of ionic calcium is needed for transmission of nervous impulses. Phosphorus is required in addition to bone formation, for the synthesis of nucleic acids and phospholipid compounds for cellular metabolism. The desirable ratio of Ca:P is 1:1 in most cases except during infancy where this ratio should be higher, i.e. 1:1.5. Another important aspect of calcium metabolism is that man can adapt to different levels of calcium intakes and a positive Ca balance can be achieved in populations which are habituated to moderate (500 mg) levels of Ca intake. The mechanism of adaptation to different levels of Ca intakes is perhaps through regulation of the enterohepatic loss of calcium through bile secretion[41].

The recently recommended intakes of Ca and P are given in Table 3. Repeated pregnancies and lactation with inadequate intake of dietary Ca by Indian women of low socio-economic groups can result in bone resorption and osteoporosis as indicated by reduced bone density[21]. This situation is quite often seen in older women in our country. A higher intake of Ca both during pre-menopausal and post-menopausal periods in our women may help to reduce osteoporosis in such women.

At present 15 trace elements are known to be essential for mammalian species of which eight elements are known to be required by humans, viz. Fe, Zn, Cu, Cr, Co, I, Mn, Mo and Se. However, deficiencies of only a few of these elements are seen in man. Iron and iodine deficiencies are widespread while deficiencies of Cu, Zn, Cr and Se have been reported in recent years. Based on the available evidence the daily requirements of the following trace elements have been recommended for Indian adults[17].

Chromium	67 μg
Copper	2.2 mg
Manganese	5.5 mg
Zinc	15.5 mg
Iodine	150 μg

It is not known whether the requirements of women are different from those of men. However, till information is available on this aspect, the above figures can be suggested for women also.

Iron Requirement

Iron is required essentially for the formation of haemoglobin which is the carrier of oxygen. It is also required for cellular functions as a component of the redox enzyme system and for myoglobin formation in muscles. There are two important features with regard to human requirement of iron. The first one is that although its physiological requirement is small, a much higher level has to be present in the diet because of limited absorption of dietary iron. The second aspect is that its requirement for adult women and adolescent girls is much higher than for the male counterpart. This is because of a higher requirement of iron by the female during the reproductive age period due to blood loss during menstruation.

The requirement of absorbed iron has been based on turnover studies to determine body iron loss[13]. Basal loss of iron has been estimated to be 14 μg/kg in the adult male. It is not clear whether turnover is lower in women as it has not been possible to carry out turnover studies in women using radio-

labelled iron. However, the same figure of 14 μg/kg is used for women also. In children, besides the basal loss, requirements for growth also have to be added. In the case of adult women and adolescent girls, iron loss through menstrual blood loss is taken into account in assessing their iron requirement.

Menstrual loss of blood, an important source of iron loss in women during the reproductive age period has been studied in Indian women by Apte and Venkatachalam[23]. They observed an average loss of 15 mg of iron per period of 0.5 mg (range 0.3 to 1.0 mg) iron per day. Taking the upper limit of menstrual blood loss, the menstrual loss of iron by adult women has been estimated to be 16 μg/kg/day or a total of 30 μg/day/kg taking the basal loss and menstrual loss together. The requirement of absorbed iron thus derived for girls and women are given in Table 4. In computing the actual dietary iron intake to meet these requirements, absorption of iron present in diet has to be considered and iron absorption varies from diet to diet and depends on its quality. Iron absorption from cereal based diets as consumed in India is quite low. This is due to the presence of significant amounts of phytate and tannins which are potent inhibitors of iron absorption. Recent studies[2] with the extrinsic tagging technique employing radio-iron and whole body counting have shown that iron absorption from Indian diets in men varies from one to five percent depending upon the principal cereal in the diet . For example, iron absorption is around five percent from rice based diets, about three percent from mixed cereal-based diets and two percent or below from wheat and millet-based diets. The higher requirement of iron in women is compensated to some extent by a higher absorption of dietary iron (Table 5). Employing the extrinsic tagging technique it has been observed that iron absorption from the same cereal-based diet is twice as much in women as in men[34]. Iron requirement and the recently recommended[17] dietary intakes of iron for women and girls are given in Table 4.

Vitamin Requirements And RDA

Fat soluble vitamins: Vitamin A (retinol) is required for proper vision and for growth and maintenance of the integrity of epithelial tissue. Vitamin A requirement in adults has been determined from long-term turnover studies[32]. On the basis of such studies, vitamin A requirement has been placed at 9.3 μg/kg. During growth, additional amount of vitamin A intake is necessary. In early infancy, vitamin A requirement is around 50 μg/kg and the requirement per kg body weight gradually declines to an adult value of about 10 μg/kg. There appears to be no sex difference in vitamin A requirement. However, if vitamin A requirement is computed on body weight basis the daily requirement of adult women would be 500 μg as compared to 600 μg in

men. However, in recommending dietary intake, no differentiation has been made between men and women and a uniform intake of 600 μg is recommended[17]. The recommended intakes of vitamin A for women of different age groups are given in Table 6.

Vitamin A requirement can also be met by ß-carotene, the provitamin form of vitamin A. Beta-carotene can be converted into vitamin A in the body, 1 μg of pure ß-carotene can give rise to 0.5μg of retinol. In case of beta-carotene present in plant foods, a correction for incomplete absorption is to be applied. Based on balance studies[39], it has been shown that only 50 percent of beta-carotene present in Indian foods can be absorbed. Thus, 1μg beta-carotene present in foods (green leafy vegetables) corresponds to 0.25 μg of retinol. Dietary intakes of beta-carotene to meet daily vitamin A requirement are also given in Table 6.

No recommendation for vitamin D is made since it is almost impossible to get vitamin D through diet except through fish liver oils. People in India who are exposed to abundant sunlight throughout the year can synthesise adequate amounts of vitamin D to meet their requirements. It is therefore essential that all children and adults must be exposed to sunlight. This may be very essential in the case of *purdah* women.

So far as other fat soluble vitamins are concerned, no specific recommendations are made since their deficiencies are not encountered in our population. So far as vitamin E is concerned, a daily intake of 0.8 mg/g of PUFA is desirable.

B-complex vitamins: The B-complex vitamins, thiamine, riboflavin and pyridoxine,function as coenzymes in cellular metabolism and are intimately concerned with the metabolism of energy, carbohydrates, proteins and fat. Their requirements are expressed in relation to energy intake, the basic requirement being 0.5, 0.6, 6.6 mg per 1,000 kcal for thiamine, riboflavin and niacin, respectively. Some studies have been reported[5, 37] on B-complex requirement of adult women using tissue saturation as the criteria. Some sex differences have been reported on B-vitamin requirement per 1,000 kcal. However, for recommending dietary allowances similar figures for requirement per 1,000 kcal have been used for both men and women. In case of B_6 daily requirements have not been determined in Indian subjects and recommended figures for daily intake based on NAS/NRS, U.S.A.[4] figures are given. Since the requirement of thiamine, riboflavin, niacin are related to energy intake, there will be sex differences in total daily requirement of these vitamins, reflecting the differences in energy requirements between males and females. In case of pyridoxine an extra intake is desirable in women on oral

contraceptive pills as chronic intake of combination oral pills may result in biochemical deficiency of B_6 [11]. Pyridoxine requirement of such women may be somewhat higher.

Vitamin B_{12} and folic acid, which also belong to this group, are haemopoietic vitamins required for the maturation of red cells and prevention of megaloblastic anaemia. However, no distinction has been made in recommending dietary intakes of these two vitamins between the two sexes.

Vitamin C is required for collagen metabolism and synthesis of other compounds (viz. steroid hormones). Its requirement appears to be the same for males and females. The requirement of vitamin C has been obtained by relating intake to tissue saturation (i.e. leucocyte levels). Although the daily requirement of vitamin C is reported to be 10-20 mg[6], dietary intake is placed at twice this amount to compensate for cooking and other losses. Although the minimal vitamin C requirement is quite low and is perhaps met by habitual diets (as evidenced by the absence of scurvy), intakes higher than RDA may be beneficial considering its effect on promoting dietary iron absorption. How much of ascorbic acid can be present to improve iron absorption from habitual diets is not known with certainty. In view of the high prevalence of iron deficiency anaemia among women and the poor absorption from the habitual cereal based diets, it may be worthwhile exploring the possibilities of improving their iron nutritional status by including adequate levels of ascorbic acid in their daily diet.

The recommended daily intakes of B-complex vitamins and ascorbic acid are given in Table 6.

Requirement Of Fat

Fat is required in the diet as a source of essential fatty acids (EFA) which are required for proper membrane function and prostaglandin synthesis. EFA requirement has been determined in various groups and it varies between three to six energy %.

Fat, besides being a source of essential fatty acids, helps in improving the energy density of foods and in adequate intake of calories, particularly by young children. This may be particularly important on a bulky cereal-based diet currently consumed in India. Fat also improves the palatability of diets.

Dietary fat may be derived from two sources: invisible fat and visible fat or the added fats and oil. Till recently the contribution of invisible fat was not considered to be significant. In recent years, improved method of fat extraction has enabled determination of total fat (both free and tissue bound). Analysis of foods including cereals and other grains has shown that cereals and pulses per se may contribute to a significant extent to the dietary fat intake as invisible fat. Since Indian diets are largely based on cereals and may contain cereals up to 500 gm, cereals by themselves can provide six percent of energy as invisible fat, a third of which is EFA (2 en%). The invisible fat from dietary cereals alone can thus meet nearly two-thirds of EFA requirement of an adult. Cereals and pulses together with invisible fat derived from milk, vegetables, meat, oilseeds and spices can contribute nearly 15 percent of total energy as invisible fat and meet the EFA requirement of an adult totally. Even in a rural diet,invisible fat contributes to about 10 percent of total dietary energy.

Taking the contribution of the invisible fat into account, desirable intakes of visible fat to meet the EFA requirement of adults and other groups and to increase energy density in the diet of children have been recently recommended. These figures are given in Table 7. It must be pointed out that while the levels of fat given in the table are desirable to meet the minimal needs, high levels of fat are considered undesirable as they may lead to cardiovascular complications in the long run. Fat intake above 30 percent of energy inclusive of visible (15 percent) and invisible (15 percent) fat is considered undesirable. This would correspond to 40 g visible fat intake a day. There may be some sex differences in the susceptibility to atherosclerosis, women are known to be less susceptible. Hence, the adverse effect of high level of fat intake may be less in women than in men, a conclusion which needs to be tested experimentally.

Nutrient Requirements And Recommended Dietary Allowance During Pregnancy And Lactation

So far as the nutritional requirements are concerned, women have the additional burden of bearing and rearing children during their reproductive age period. During pregnancy and lactation, the nutritional requirements of women increase significantly to meet the extra demand of these additional physiological stresses. During pregnancy, additional nutrients are required for the growth of the foetus, expansion of maternal tissues like placenta adnexa, and fat stores. During lactation, nutrients are transferred through the breast

milk to the infant for its growth and development from the mother. These losses of nutrients through breast milk have to be replenished to maintain the nutrition and health of the mother at the normal level. Additional nutrients required during pregnancy and lactation have been computed essentially by the factorial method. The extra nutrients deposited in the foetus and the maternal tissue during gestation and nutrients secreted in breast milk during lactation are computed using the available data on body weight and body composition changes during pregnancy and volume of breast milk secreted during lactation.

A normal well nourished European or North American woman with body weight of 55 kg gains about 12.5 kg during pregnancy and delivers a baby of 3.3 kg body weight [8]. These figures will be somewhat lower in well nourished Indian women with a nonpregnant body weight of 50 kg. However, Indian women belonging to the low socio-economic groups with body weights of 40-42 kg are reported to gain less than 7 kg and give birth to an infant of 2.5 kg, reflecting the poor nutritional status of the mother. It was assumed earlier that the daily breast milk output during the first six months in a normal woman is 850 ml. However, more recent comprehensive studies indicate that medium volume of milk secreted is only about 700 ml/day[44]. Indian women belonging to low income groups are reported[15] to secrete only 600 ml of milk during the first six months and 500 ml from six to 12 months of lactation. This is considered a fairly satisfactory lactation performance of Indian nursing mothers, considering their poor nutritional status.

Energy

Pregnancy: The total energy cost of pregnancy for a woman weighing 55 kg and giving birth to an infant of 3.3 kg has been estimated to be 80,000 kcals[20]. Assuming that these values will be lower for a normal Indian woman with a body weight of 50 kg, an additional daily energy intake of 300 kcals has been considered to meet the additional energy demands of Indian pregnant women during the second and the third trimester[15, 17].

Lactation: Assuming a maximal milk output of 850 ml and 80 percent efficiency of conversion of food energy into milk energy, an additional intake of 550 kcal per day has been recommended[17,44] during the first six months of lactation. Since Indian women continue to breast feed their infants beyond six months up to one year or more, however, with a reduced milk output, an extra allowance of 400 kcal/day has been recommended during six to 12 months of lactation.

Protein

Pregnancy: On the basis of reported nitrogen deposition during pregnancy in well nourished women, additional dietary protein intake of 14 g/day (NPU 65) has been recommended for Indian pregnant women[44]. This figure has been further revised recently to 15 g/day[17] in line with the recent recommendations of FAO/WHO/UNU Consultative Committee[20].

Lactation: Assuming a maximal milk output of 850 ml, with a protein content of 1.2 g/dl, an additional daily protein intake of 25 g dietary protein of 65 NPU during the first six months of lactation has been recommended[17]. However, during six to 12 months,when volume of milk output declines, the suggested daily intake of protein is 18 g.

Fat

The EFA requirement is increased during pregnancy and lactation. In comparison with normal women who need EFA of only 3 en%, pregnant and lactating women require EFA of 4.5 and 6.0 en% respectively[17]. In addition to EFA provided by the invisible fat of the diet, the visible fat (vegetable oil) intake to provide the above level of EFA is 10 and 15 en% respectively. However, to provide enough energy density to the diet to ensure extra intake of energy an additional intake of 15 en% and 20 en% or a daily intake of 35 and 45 g of visible fat respectively are recommended.

Minerals

Calcium: During pregnancy and lactation there is a need for an extra intake of calcium of 300-400 mg/day, for foetal bone growth or for milk secretion. To provide this level of extra calcium in addition to normal requirements, an intake of 1 g of dietary calcium has been suggested during pregnancy and lactation [15] with a Ca:P ratio 1:1 [17].

Iron: Requirement of iron is increased considerably during pregnancy, but not during lactation. Additional iron requirement during pregnancy is computed from a knowledge of iron needs for foetal growth, expansion of maternal tissue including red cell mass, the iron content of placenta and the blood lost during parturition. However, during pregnancy, there is a saving of iron loss in menstrual blood. The net requirement of iron during pregnancy to

maintain normal haemoglobin and iron status in the mother and the infant is estimated to be 0.63 mg, 3.3 mg and 5.0 mg per day during the first, second and the last trimester respectively. This works out to a daily iron intake of 60 μg/Kg during the latter half of pregnancy. Absorption of iron during pregnancy from the mixed cereal diet habitually consumed in India is reported to be about eight percent[3]. Daily food iron requirement will therefore be 37.5 mg. Since it may be difficult to provide all this iron through diet alone, prophylaxis iron supplementation becomes necessary to prevent anaemia of pregnancy.

Lactation: Iron requirement during lactation is the sum of the normal requirement of the mother and that required to replace the iron lost in breast milk. Since there is amenorrhaea during lactation, the basal requirement of iron of lactating women will be the same as for men, i.e. 14 μg/kg and, for milk secretion, additional intake of 1 mg/d or 16 μg/kg is necessary. The daily iron requirement during lactation is therefore 30μg/kg or 1.5 mg/day. In terms of dietary iron from a mixed cereal diet with an absorption of five percent the requirement would be 30.0 mg/day.

Vitamins

Vitamin A: Additional requirement of vitamin A during pregnancy is quite small (25 μg) and the daily intake of 600 μg of retinol or 2,400 μg beta-carotene would cover the requirement during pregnancy also. However, during lactation about 350 μg retinol is lost daily in milk (50 μg/dl in 700 ml milk). The RDA of additional intake of 350 μg of retinol or 1,400 μg of beta-carotene has been recommended by the 1988 Expert Group of the ICMR[17].

B-complex vitamins: The additional requirement of B-complex vitamins, thiamine, riboflavin and nicotonic acid are related to additional energy allowance for pregnancy and lactation, the basic allowance being 0.5 mg, 0.6 mg, 6.6 mg per 1,000 kcal for thiamin, riboflavin and niacin, respectively.

Pyridoxine requirement during pregnancy and lactation will be 2.5 mg/day as compared to 2.0 mg for a normal woman.

Since the folate requirement is considerably increased during pregnancy, an additional intake of 300 μg of folate over and above the normal intake of 100 μg/day is recommended[15]. An extra intake of 0.5 μg of vitamin B_{12} (total 1.5 μg/d) has also been suggested during both pregnancy and lactation.

Ascorbic acid requirement is not altered during pregnancy. During lactation an additional daily intake of 40 mg to cover losses of ascorbic acid in breast milk is suggested[15]. Nutrient allowances during pregnancy and lactation are given in Table 8.

Metabolic Adaptation In Pregnancy And Lactation

The current estimates of nutritional requirements during pregnancy and lactation assume that they require additional amounts of nutrients over and above the requirements during their normal state. It has been observed, however,in many dietary surveys that women during pregnancy and lactation normally do not increase their nutrient intake over the pregnancy intake[22] and still perform their function of child bearing and child rearing satisfactorily. This raises the question whether there is metabolic adaptation during these two physiological conditions resulting in a better utilisation of nutrients even on a normal intake, so that the additional needs during these two conditions are met. There is some experimental evidence to indicate that there is an element of adaptation in the utilisation of protein, iron and calcium and possibly energy. A common form of adaptation to lower energy intakes during pregnancy is to reduce physical work. However, any evidence of metabolic adaptation to improve efficiency of energy utilisation during pregnancy is not yet available. Adaptation to lower protein intakes seems to result in a better utilisation of dietary protein. It has been shown[36] that in Indian women of low income group on the same pre-pregnancy intake of protein of 40 g/day (i.e. 1 g/kg), nitrogen retention increases progressively as pregnancy advances. Subjects who were near balance during the first trimester on a protein intake of 40 g/day tend to retain 2-3 g N in the third trimester on the same intake. However, during lactation the subjects go into a negative balance indicating that an intake of 40 g of protein daily is clearly inadequate during lactation. Improved absorption of dietary iron[3] and calcium[40] in Indian women during pregnancy as compared to non-pregnancy women has been reported. The available limited data do indicate that at least during pregnancy there is some evidence of metabolic adaptation leading to better utilisation of some nutrients,namely protein, iron and calcium. Clearly, more studies are needed on this subject before this factor of adaptation and better utilisation of nutrients can be taken into account in our assessment of nutrient requirements during pregnancy and lactation.

Conclusions

Women and girls constitute a special group with regard to nutritional requirements: As a special group girls and women in general have a nutritional requirement similar to that of males. The physiological requirements of most of the nutrients have been determined in males and the same values per

kg body weight are used for assessing the requirement of girls and women also, after making corrections for their actual body weights which are lower than those of boys and men. However, limited studies on the requirements of women for some of the nutrients indicate that their requirements per body weight may be somewhat lower than men. There are some important differences in the nutrient requirement that depend upon the body size and basal metabolism. These are energy, protein, B-complex vitamins. Daily requirement of these nutrients are lower in women as compared to men due to their lower body weights and lower BMR. On the other hand, the requirement of nutrients concerned in haemopoesis like iron and folate, are higher in adult women and adolescent girls due to menstrual loss of blood. Thus, iron and folate requirements are higher in these two groups. However, to compensate for the higher requirement of iron, dietary iron absorption is higher in women than in men.

An important aspect of nutritional requirements of women is the increased requirement during their reproductive age period for their additional function of child bearing and child rearing. The extra requirements of nutrients during pregnancy and lactation have been computed through a factorial approach, which assumes that the additional requirements are equal to those that are needed for foetal growth and maternal tissue expansion during pregnancy and breast milk secretion during lactation. There is some evidence for metabolic adaptation,at least during pregnancy, which appears to result in a better utilisation. This factor,however,is not considered currently for fixing the nutrient requirement during pregnancy and lactation.

The current intakes of foods and nutrients by Indian women and girls and their adequacy: It is widely acknowledged that the dietary intake of nutrients of a majority of rural Indians and underprivileged urban population of both sexes are below the desirable levels. The extent of deficiencies depends upon the age and socio economic status. In most of the diet and nutrition survey data, separate figures for women are hardly presented, only intake data per capita or per consumption unit are presented. It is lately believed that woman and girls are much worse off than their male counterparts with regard to dietary intakes. However, this presumption is not based on any hard data, but only reflects our concern for the female members of the society who have a lower social status than men. Let us examine whether the presumption of sex bias in dietary intake is true. Data collected by NNMB, though not exhaustive, provides some useful information to examine the above question. Using the same data source the question of variation of intake from one state to another state and the question of time-trend with regard to nutrient intakes by women will also be examined.

Nutritional Requirements of the Present Population

The recommended dietary allowances of nutrient intakes discussed in the earlier section are for a healthy population with normal body weights. The actual body weight of our population of different age groups, particularly of those belonging to the low income groups are below the reference body weights as a result of chronic malnutrition from birth to adulthood. The low body weights we see among our adult population is the cumulative effect of undernutrition right from conception through infancy, childhood and adolescent periods.

The requirements of most of the nutrients are roughly proportional to the body weight. In case of stunted adults who do not have any potential to grow and make good deficits in their body stature and weight, requirements would be relatively less and for this reason adjustment for their current body weights would be justified. However, for other groups like children and adolescents, who have the potential to grow and make good any deficit in their body weights, nutritional allownaces should be similar to the RDA meant for those with normal growth and body weights. This would presumably enable them to make good any deficit in their body weights since they have a potential to grow[20]. These guiding principles will be followed in assessing the adequacy or otherwise of the diet and nutrient intake of our female population of different ages belonging to different socio-economic status in the urban and the rural areas of India.

Current body weights of our population: The current body weights (average) of female population of different ages belonging to different socio-economic groups are given in Table 9, along with the reference body weights employed for recommending dietary allowances of nutrients[17].

It can be seen from the table that while the average body weights of those belonging to HIG and MIG in urban areas are similar or closer to the reference body weights, the body weights of those belonging to other low income groups, namely LIG, IL and slum groups, in urban areas and the rural groups are significantly below the reference body weights. The body weights decrease in the following order:

HIG > MIG> LIG> IL> Rural> Slum.

Those belonging to LIG and IL have similar body weights, while those from the slums are the worst off. Body weights of rural groups are slightly better than those of the slum population. The body weights of rural and slum population which constitutes a majority of our population is 70-85 percent of the reference body weights at different ages.

These deficits in body weights actually reflect the chronic situation with regard to the degree of inadequacy in food and nutrient intakes by our population. Only the HIG and MIG groups among the urban population appear to be meeting their nutritional requirements adequately. The other groups are obviously not meeting their nutritional requirements, the slum and the rural women are the worse off in this respect.

Actual nutritional requirement of adult population: As discussed above, while examining the adequacy or otherwise of the current dietary intakes only in the case of adults (29-40 years), the RDA can be adjusted for their current body weights, while in case of those below 18 years, the actual RDA based on desirable body weights have to be considered for assessing the adequacy of their current intakes. The body weights adjusted requirements of energy and protein for adult women are given in Table 10. The desirable intake of nutrients by adult females belonging to various socio-economic groups varies from 84 percent in the case of slum dwellers to 100 percent in the case of HIG. It is suggested that while assessing the adequacy of the current intake of energy and protein by adult women, intake values are to be compared with the suggested intake values given in this table. For other age groups, the actual RDA for infants and children and adolescents as given in Tables 2, 3, 4 and 6 have to be used for examining the adequacy of their current intakes.

Intake of foodstuffs by different socio-economic classes: Currently available data on the daily intake of foodstufs by adults are given in terms of consumption units (CU) corresponding to a sedentary male. While expressing intakes in terms of CU from household dietsurvey data, it is assumed that the intra-familial distribution of food is in accordance with physiological requirements; appropriate coefficients for age and sex of individual family members are applied in this calculation. Food intake data for the period 1975-80 for different socio-economic groups of rural and urban population reported by NNMB[25] are given in Table 11.

It would be of interest in this context to know whether intakes of foodstuffs by women is different from those of men, both quantitatively and qualitatively. Dietary intake data from Andhra Pradesh based on the oral questionnaire method on adult women and men are available for comparison. These data are given in Table 12. Intake data presented in this table for adult men and women indicate that the cereal intake is slightly (10 percent) lower in women than in men. Considering that women have lower body weight and hence their nutritional needs are lower, the dietary intake data suggest that a woman's dietary intake satisfies her nutritional needs to the same extent as it does in the case of men.

The main features of these intake data presented in Table 11 are that cereals predominate the diets of women irrespective of their socio-economic status both in urban and rural areas. The common feature of the diets of the low income groups, both in the urban (LIG, IL and slum) and rural areas is the low intake of protective foods like pulses, leafy and other vegetables, fruits, milk, oils and fats and flesh foods including fish. The intake of these income elastic foodstuffs are however quite satisfactory among the urban HIG and MIG groups, but they fall sharply and further decrease as one goes from HIG and MIG to LIG and IL to rural and slum population. The intakes of rural women fall between those of LIG and the slum population.

A comparison of the intakes of various foodstuffs by different groups with the suggested balanced diets of the ICMR[15] for a moderately active woman (CU=1) indicate that only the urban HIG, MIG and rural high income (> 150/month) groups consume diets comparable to a balanced diet. The other low income groups both in urban and rural areas do not consume any of the foods in suggested amounts except cereals. Among urban groups, cereal intake is higher among low income groups as compared to HIG and MIG. However, such differences in cereal intake among different income groups are not seen in rural areas. Cereal intake among urban groups is generally lower than among the rural groups by nearly 80-100 gm. Surprisingly the intake of green leafy vegetables is uniformly low among all the groups, the intake being in the range of 10 to 20 gm a day which is much below the amount suggested for a balanced diet.

Nutrient intakes by women and girls: The intake of nutrients by men and women in Andhra Pradesh are given in Table 12. It can be seen that there is not much of difference between the two sexes in the dietary intake of nutrients. Nutrient intake of women is lower than RDA in case of energy, Ca, iron, vitamin A, riboflavin, vitamin C and folate. If an adjustment is made for lower body weight of rural women, the average intake appears to be satisfactory with regard to energy, protein , calcium, thiamin, nicotinic acid. However, intakes of vitamin A, iron, riboflavin and ascorbic acids are still inadequate. A comparison of the average intakes of nutrients by different income groups in urban areas and the average intake in the rural areas with RDA also indicates a similar trend. The intakes of energy, protein, calcium, thiamin, niacin and vitamin C are comparable to or above RDA in all groups. However, the intakes of iron, vitamin A, riboflavin are below RDA in all groups except HIG. The extent of inadequacy of these nutrients increases as the income decreases.

The main observations emerging from an examination of intake data are that except for high income groups, most of the urban and rural low income groups have varying degrees of inadequacy of intake of iron, vitamin A, ribo-

flavin. Although energy deficiency is not serious among the adults, energy deficiency is an important problem in the dietaries of preschool children as will be discussed later. Some data are available on the intakes of the above four nutrients by certain age groups of both sexes. These are based on the oral questionnaire method of diet survey in 10 states carried out by NNMB over the period 1975-80[25]. Based on these data, differences in the intakes of energy, protein, iron and vitamins are discussed below. Also nutrient intake in relation to income will be discussed wherever data are available.

Sex differences in the intakes of protein and calories: Intakes of energy and protein of different age groups by sex are given in Table 12. These are pooled data collected by NNMB in the rural areas of 10 states during 1975-80 by the oral questionnaire method[25]. It will be seen that the daily intake of energy of males and females do not differ up to the age of 12 years. However, during adolescence and adulthood the intakes of energy by the males are somewhat higher. The higher RDA for boys is not reflected in intakes. The average intakes of energy is much lower than the RDA in both sexes up to the age of 18 years. However, energy intake of adults after adjusting for lower body weights of rural population appear to be just adequate. The adult body weight is about 85 percent of the reference body weight on which RDA is based. In case of women, the body weight of rural adult women is 85 percent of reference body weight and her actual requirement for sedentary occupation will be 1,500 kcal and for moderate work 1,785 kcal. In case of girls up to 18 years, the actual mean intake is 75 percent of RDA up to 12 years and about 80 percent RDA in adolescence. Among boys the intake is 65 percent of RDA up to 12 years and about 75 percent RDA during adolescence. It would appear that energy intake of girls is a bit better than of boys.

As far as protein intake is concerned, the average intakes are close to RDA up to the age of six years both in boys and girls. However, during the school age and adolescent periods, protein intakes are below RDA in both boys and girls.

In Table 14 are given the calorie intakes of females and males as percent of RDA for different age and income groups. It will be seen that there are no significant differences in the energy intake between females and males. Actually, in the higher age groups beyond the age of 13 years, the females appear to have a better energy intake in all the socio-economic groups. It is also observed that in both sexes up to the age of 15 years, the energy intakes satisfy only 65-75 percent of RDA. However, in adults the requirements is met to the extent of 100 percent. It is also seen that the energy intake as percent of RDA increases with income in all the age groups. This increase is more significant in the younger age groups than in the older age groups.

From the above analysis, it would appear that insofar as the energy and protein intakes are concerned, there are no differences relative to RDA in the intake of male and female at any age and intakes in both the sexes meet the RDA to similar extents. In fact, during adulthood, dietaries of women appear to satisfy requirement better than those of men. The extent of energy and protein deficiencies prevailing among the poor rural and urban community are the same in both males and females and there is no evidence from the diet survey data that females do not suffer more in this respect.*

Sex differences in the intake of iron and vitamins: Data based on the NNMB survey with regard to intake of the other two critical nutrients, iron and vitamin A,are given in Table 15. It will be seen that as compared to RDA, vitamin A intake is only one-third both in girls and boys. As far as the iron intakes are concerned, the intake in girls is much below RDA, while in males it either matches with RDA or is only slightly below it. These differences are seen in adolescents and adults, where the intake data have been segregated according to sex. However, there are no segregated data for preschool children and school children. Intake of vitamin A is much below RDA and iron intake is 10-12 percent below RDA in these two groups. These data indicate that there is uniform gross inadequacy of vitamin A intake in all the age groups irrespective of sex. With regard to iron intake, female intake is much more below requirement than that of males. This perhaps explains the greater prevalence of iron deficiency anaemia in women as compared to men.

Prevalence of nutritional deficiencies: As a consequence of inadequate dietary intake of energy, protein, vitamin A, iron and riboflavin, nutritional deficiencies are widespread in our country, particularly among the low income group population both in the urban and rural area. The major nutritional deficiencies prevalent in India are protein energy deficiency and vitamin A deficiency among children, and iron and B-complex deficiency among all groups. Although B-complex deficiency occurs widely, it is not known to be associated with any disability. Hence the major dietary deficiencies of concern from a public-health point of view are protein-energy malnutrition, vitamin A deficiency and anaemia. The current situation with regard to prevalence of these deficiencies which reflect dietary inadequacies among women and girls, in comparison with that of men and boys, will be discussed. Also the prevalence of these deficiencies in relation to income will be discussed wherever information is available.

**The great majority of poor women in reproductive ages, in our country, are either pregnant or lactating (or both) at any given point of time. If current dietary intakes as reflected in the diet survey data as discussed above are compared against the increased requirements in pregnancy or lactation, women could be seen to be subject to greater degrees of nutrient deficit than men — Editor.*

Protein-energy malnutrition: Protein-energy malnutrition is a major nutritional deficiency disease affecting preschool children. Although clinical deficiency syndromes like marasmus and kwashiorkor occur only in one to two percent of children, a larger proportion of the affected children, nearly 80 percent, have growth retardation of different degrees. The extent of growth retardation actually represents the extent of deficiency of intake of energy and other nutrients essential for growth and also the adverse interaction of environmental factors. The extent of growth retardation in these children is expressed in terms of their body weights as percent of standards, that is body weights of age-matched well-to-do Indian children (Gomez' classification). Gomez' classification of rural and urban children as reported by NNMB is given in Table 16 for girls and boys separately.

It will be seen that both in rural and urban areas girls are better off as compared to boys. The percentage of children in the normal group is nearly twice in girls when compared to boys. Similarly, the percentage of girls with severe degree of malnutrition is about half of that seen in boys. The prevalence of moderate degree of malnutrition is lower among girls than boys, the ratio being 2:3. It would appear from this large data base collected from different parts of the country over a five year period that among preschool children, girls fare better as far as the intake of energy and protein and other nutrients and the resulting prevalence of PEM is concerned.

Vitamin A and B-complex deficiencies: The prevalence of vitamin A and B-complex deficiency signs in females and males at different ages as reported by NNMB is given in Table 17. It can be seen that the prevalence of vitamin A deficiency signs are generally lower among females as compared to males at different ages. Similarly, the prevalence of B-complex deficiency signs are also lower in females as compared to males during the school age and adolescent periods. Because of a wide variation in the prevalence between states and periods, these differences may not be significant. However, it can be safely stated that girls and women are not worse off than boys and men with regard to the prevalence of these two deficiencies.

Anaemia: Anaemia is considered to be generally higher among women than among men. NNMB has not reported prevalence of anaemia since haemoglobin determinations were not included in its survey protocol. Most of the data available on anaemia are hospital-based surveys. However, a few population surveys have been reported in recent years. One such rural survey was carried out as a part of the iron-fortified salt evaluation study in four locations in the country, namely, Madras(city), Hyderabad (rural), Delhi (rural) and Calcutta (rural) covering a population of two or three thousand at each centre[38]. The results of this survey are given in Table 18. The prevalence of anaemia was quite high both in males and females at all centres except the

urban centre of Madras. The prevalence was uniformly higher in females than in males, the difference being much greater among the adults of 25-44 years. The same trend is seen in another recent survey in 1984 where a population of 5000 was surveyed in a rural area near Hyderabad[24].

It would appear from the available epidemiological data that insofar as the prevalence of PEM, vitamin A and B-complex deficiencies are concerned, females are not worse off than their male counterparts. On the other hand, girls are in fact better off than boys in having a lower prevalence of these deficiencies. These differences in prevalence of deficiencies between the two sexes do indicate that the dietary intakes of these nutrients are better in females than in males. However, with regard to anaemia, girls and women are worse off particularly in the adolescent and adult period. This is understandable since the iron requirements of women are much higher than men and similar dietary intakes of iron can satisfy less of women's requirements than of men's.

Regional differences in the dietary intakes of nutrients by girls, women and their nutritional status: It was indicated earlier that insofar as food and nutrient intakes and nutritional status are concerned, there is no difference between men and women and in fact women are better off than men with respect to prevalence of deficiencies of several nutrients. However, the data on men and women discussed above are pooled from 10 states of the country. There may be regional differences with regard to dietary intakes and nutritional status of women. The dietary and nutrient intakes and the nutritional status of women in different states where NNMB has collected data can be examined to identify regional differences, if any.

As pointed out in the earlier sections, most of the dietary intake data reported by NNMB are based on household surveys. What these data reported as average intake per CU can be considered to reflect the intake of women also (loc cit). Average intakes of foodstuffs in 10 states per CU are given in Table 19. Also included in the table are the diet survey data for states not covered by NNMB, but covered by the dietary surveys carried out by F & NB[12]. From these data the following points can be made: in general, cereals and millets predominate the diets in all states, there being some differences in the amounts consumed, the lowest being in Kerala and the highest being in Karnataka. As regards intake of protective foods like pulses, vegetables, milk, fruits and flesh foods the intakes are uniformly low in all states. Milk consumption however is satisfactory, that is, above 150 g in the states of Gujarat, Punjab and Haryana, the last two having a daily consumption of milk above 300 g. Milk consumption in the states of Kerala, West Bengal and Orissa, on the other hand, is very low, 35 g or below. Pulse consumption is lower in Kerala and West Bengal than in other states. However, the consumption of tubers (tapioca) and fish are the highest in Kerala.

Segregated data for the intake of certain critical nutrients like energy, protein, iron and vitamin A by women and girls are, however, available for different states from the NNMB surveys. In Table 20, pooled data for 1975-80 on energy and protein intakes by age as percent of RDA in 10 states are given. It can be seen from this table that energy intake of preschool children is below requirement in all states, adequacy (as compared to RDA) is 70 percent or below in Kerala, Orissa, West Bengal, U.P. and A.P. and 80-90 percent in Karnataka, Gujarat and M.P. As regards energy intakes of school age and adolescent groups, a similar extent of deficit exists in all states with much lower intakes in Kerala. In adults, intakes are 90 percent or above in all states, except in Kerala where intake is only 77 percent of adequacy. The level of protein intake in preschool children is relatively more adequate than the level of energy intake. Adequacy below 75 percent is seen only in Kerala and Orissa. As far as school age is concerned, intakes are fairly satisfactory in all states except in Kerala. Inadequacy of protein intake by adolescent girls is seen in all states. States with below 75 percent adequacy are Kerala, Tamil Nadu, A.P., Orissa, West Bengal and Maharashtra. As far as intakes of adult women are concerned, they are adequate in all states except in Kerala and West Bengal. Thus, as far as adequacy of energy and protein intakes by girls and women is concerned, Kerala ranks the lowest.

The vitamin A and iron intakes of different age groups are given in Table 21. The figures for preschool children represent both sexes. Iron intakes are below RDA in all states, the deficit being larger in Kerala and A.P., the intakes being 37 percent, 51 percent of RDA in all states except Karnataka. Here again iron intake in Kerala is very low, that is about 50 percent of RDA, in all the age groups. Vitamin A intake is below RDA in all states and in all age groups. Only in Gujarat and West Bengal, the intakes are higher than in other states and meet around 50 percent of the requirement. In other states, intakes are one-third or below of the RDA.

Protein energy malnutrition among one to five years indicated by weight deficit according to Gomez' classification is shown in Table 22. Again there are wide variations between states. As far as severe grades are concerned, the figures for Karnataka, Maharashtra, M.P., Gujarat are higher than for other States. It is quite low in Kerala and Tamil Nadu. It is rather surprising that in Kerala in spite of the intake of energy and protein being lowest, the prevalence of severe grades of malnutrition is also the lowest. This may be due to better control of infections because of a better health service; the superimposition of acute infections often tends to push children in moderate grades of undernutrition into the severe stages.

It would appear that there are considerable variations between states among women and girls, with regard to intakes of nutrients, prevalence of

deficiencies and grades of malnutrition among preschool children. However, such differences exist in males also to more or less the same extent. Some states are worse off than others, but such differences may not reflect social oppression of women. For example, Kerala stands out as a state where nutrient intake by women is the lowest in spite of Kerala women having a better social status than in other states. The nutrient intakes by women in different states perhaps reflect the level of socio-economic development, food availability, population density, rather than discrimination against the female sex.

Time trends in dietary intakes of women: Diet and nutrition surveys have been carried out in different states of India by the State Nutrition Department of the Directorate of Health Services, since 1935. The results of these surveys during 1935-65 have been compiled and published annually by the ICMR. However, these data have not been collected on the basis of systematic sampling procedure. They are the results of surveys carried out randomly in isolated locations in the states and hence do not represent directly the status of dietary intake of a state or a specific region in the states. Also the data are given as per capita without segregating into sexes. Hence, these data are not useful for assessing the time trends in dietary intakes of women over the decades by comparing them with data collected systematically by NNMB during the latter half of the 1970s[25]. NNMB has been collecting data in 10 states since 1975 using statistically selected samples so as to represent the dietary situation at the state level. The earlier data collected by the states during 1935-65 cannot be compared with data collected by NNMB during 1970s to discuss any time trends. However, data on body weights of the population collected on a comparable group at different periods can be compared to obtain an idea of changes in diet and nutrition situation of the population on which their growth and body weights depend. Some data on body weights of girls five to 13 years collected in rural areas of Madras state in 1954[14] and recently by NNMB in Tamil Nadu can be compared. These data are given in Table 23. Also ICMR collected on an all India basis[16] anthropometric data on children from both urban and rural areas during the years 1956-65. The data on rural girls can perhaps be compared with NNMB rural data collected during 1975-80 to discern any changes in the nutritional status of girls over this decade. These data are also given in Table 22. If one compares body weight data for age groups of rural girls between 1965 and 1974-80 given in Table 23 there appears to be not much change over this decade, except for adolescent girls (16-18 years) who show better body weights now. There are also no changes in the body weights of rural preschool children (one to five years) between 1965 and now.

It can be concluded that there are no reliable data on dietary intakes of women and girls in the earlier decades comparable to what we have at present from NNMB. Hence no definite conclusions can be drawn about changes in dietary intakes by women over the decades preceding the 1960s.

Table 1

Energy Intake of Well-to-do Indian Preschool Girls

Age years	Study details Height (cm)	Weight (kg)	Energy intake (Kcal/day)	RDA ICMR (1988)
2-3	93.0	12.5	1133	1095
3-4	103.3	15.7	1395	1250
4-5	110.2	16.6	1417	1450
5-6	112.9	17.3	1418	1595

Table 2

Recommended Dietary Allowances of Energy and Protein for Indian Women and Girls

Particulars	Reference body wt. (kg)	Daily recommended allowances Energy (kcal)	Protein (g)	* Protein-energy ratio (%)
Adult women:				
Sedentary	50	1800	50	11.1
Moderate	50	2100	50	9.5
Heavy	50	2450	50	8.2
Children				
1-3 yrs	11.8	1050	22.5	8.6
4-6 yrs	17.7	1500	28.5	7.6
7-9 yrs	25.0	1800	43.0	9.6
10-12 yrs	35.0	1950	62.0	12.7
Adolescents:				
13-15 yrs	47.8	2050	65.0	12.7
16-18 yrs	49.7	2050	66.0	12.9

* $\frac{\textit{Protein requirements} \times 4}{\textit{Energy requirements}} \times 100$

Table 3

Suggested Intakes of Calcium, Phosphorus (mg/kg) for Girls and Women

Group	Calcium	Phosphorus
Adult women	400	400
Infants	500	750
Children:		
1-9 yrs	400	400
10-15 yrs	600	600
16-19 yrs	500	500

Table 4

Recommended Allowances of Iron for Indian Women and Girls

Group	Iron requirements		Dietary iron requirements (mg/day)		
	Absorbed μg/kg b.wt.	Iron μg/day	Mixed cereal diets	Rice diet	Wheat/ millet diet
Adult women	30.0	1.50	30.0	18.8	45.5
Children:					
1-3 yrs	29.0	0.35	11.6	7.0	17.4
4-6 yrs	29.0	0.54	17.9	10.7	26.9
7-9 yrs	29.0	0.75	24.8	14.9	37.3
Adolescents:					
10-12 yrs	30.0	1.01	20.2	12.2	30.6
13-15 yrs	30.0	1.39	27.7	16.7	42.0
16-18 yrs	30.0	1.50	30.0	18.8	45.5

Table 5

Dietary Iron Absorption in Indian Women and Girls

Group	Mean dietary iron absorption (%)		
	Rice based diet	Mixed cereal based diet	Wheat/millet based diet
Adult women	8.0	5.0	3.3
Adolescent girls	8.0	5.0	3.3
Post-menopausal women	5.0	3.0	2.0
Anaemic women	16.0	10.0	6.7
Children (girls)	5.0	3.0	2.0

Table 6

Recommended Dietary Allowance of Vitamins for Indian Women and Girls

Group	Vit. A (μg/day)		B-complex vitamins						Ascorbic acid mg/d
	Retinol	ß carotene	Thiamin mg/d	Riboflavin mg/d	Niacin mg/d	Pyridoxine mg/d	Folic acid μg/d	Vit. B_{12} μg/d	
Women:									
Sedentary	600	2400	0.9	1.1	12	2.0	100	1	40
Moderate	600	2400	1.1	1.3	14	2.0	100	1	40
Heavy	600	2400	1.2	1.5	16	2.0	100	1	40
Children:									
1-3 yrs	400	1600	0.6	0.7	7	0.9	100		40
4-6 yrs	400	1600	0.8	1.0	11	0.9	100		40
7-9 yrs	600	2400	1.0	1.1	13	1.6	100		40
10-12 yrs	600	2400	1.0	1.2	13	1.6	100	0.2-1.0	40
Adolescents:									
13-15 yrs	600	2400	1.0	1.2	14	2.0	100		40
16-18 yrs	600	2400	1.0	1.2	14	2.0	100		40

Table 7

EFA and Fat Requirement of Indian Women and Girls

Fat requirement	Adult women and older girls	Young girls (1-5 yrs)
EFA–en %	3	3
Invisible fat*–en %	10	10
Visible fat–en %	5	12
g/day	15	20

**5 percent would be from cereals and pulses and the rest from milk, nuts, spices, etc.*

Table 8

Additional Nutrient Allowances During Pregnancy and Lactation

Nutrients	Pregnancy	Lactation	
		0-6 months	6-12 months
Energy, kcal	300	550	400
Protein, g	15	25	18
Fat, g	10	25	25
Calcium, mg	600	600	600
Iron, mg	8	–	–
Retinol, μg	–	350	350
Thiamin, mg	0.2	0.3	0.2
Riboflavin, mg	0.2	0.3	0.2
Nicotinic acid, mg	2.0	4.0	3.0
Pyridoxine, mg	0.5	0.5	0.5
Folate, μg	300.0	50	50
Vitamin B_{12}, μg	–	0.5	0.5
Ascorbic acid, mg	–	40.0	40.0

Table 9

Current Body Weights (kg) of Indian Women and Girls of Different Ages belonging to Different Socio-economic Groups

Group	Reference body wt.	Urban					Rural
		HIG	MIG	LIG	IL	Slum	
Infants: 0-1 yr	7.2	6.2	6.0	5.9	5.9	5.7	5.8
Children:							
1-3 yrs	11.8	11.2	10.6	9.5	9.5	9.0	9.1
4-6 yrs	17.7	15.7	14.4	14.0	14.3	13.6	13.6
7-9 yrs	25.0	19.6	19.9	18.8	18.7	18.3	18.3
10-12 yrs	35.0	26.4	27.3	25.4	25.4	24.0	24.6
Adolescents:							
13-15 yrs	47.8	39.5	37.5	35.4	35.7	33.8	34.7
16-18 yrs	49.7	43.8	43.1	41.7	41.6	40.8	41.1
Adult women	50.0	50.3	48.2	43.5	44.6	41.9	42.5

Table 10

Recommended Intakes of Energy and Protein by Adult Women of Different Socio-economic Groups Adjusted for Current Body Weights

Socio-economic group	Energy requirement kcal/day			Protein g/day	Percent of reference
	Sedentary activity	Moderate activity	Heavy activity		
Reference women	1800	2100	2450	50	100
Urban: HIG	1800	2100	2450	50	100
MIG	1735	2024	2362	48.2	96
LIG	1566	1827	2132	43.5	87
IL	1606	1873	2185	44.6	89
Slum	1508	1760	2053	41.9	84
Rural	1530	1785	2083	42.5	85

Table 11

Current Intakes of Foodstuffs (g) per CU per Day by Different Socio-economic Groups in India

Socio-economic groups	Cereals	Pulses	Vegeta-bles*	Roots and tubers	Flesh foods	Milk	Fats and oils	Sugar and jaggery	Nuts and oil seeds	Condi-ments and spices
Urban: HIG	316	57	113 (21)	82	31	424	46	34	21	13
MIG	361	49	89 (21)	78	22	250	35	31	15	13
LIG	428	42	55 (16)	66	19	95	22	28	13	16
IL	420	41	56 (13)	67	22	98	23	29	14	14
Slum	416	33	40 (11)	70	19	42	13	20	9	12
Rural monthly income (Rs.) groups:										
<30	495	27	46 (13)	169	–	39	5	6	–	–
30-60	526	34	56 (11)	123	–	66	8	9	–	–
60-90	529	44	67 (11)	87	–	108	13	15	–	–
90-150	551	49	72 (12)	58	–	150	17	20	–	–
>150	497	50	78 (12)	56	–	235	25	27	–	–
Rural: Average	515	30	57 (12)	100	–	83	9	11	–	–
ICMR: Balanced diet	440	45	40 (100)	50	–	150	25	20	–	–

* *Figures within parantheses refer to green leafy vegetables*

Table 12

Mean Intakes of Foodstuffs and Nutrients by Adult Women (> 18 yrs) in Andhra Pradesh Compared to Adult Males

Intake of foodstuffs g/caput/day			Intake of nutrients per caput/day		
Foodstuffs	Women (386)	Men (314)	Nutrients	Women	Men
Cereals	413 ± 7.6	460 ± 8.8	Calories (kcal)	1701	1868
Pulses	23 ± 1.3	23 ± 1.3	Proteins (g)	48.7	53.9
Leafy vegetables	6 ± 1.2	6 ± 1.2	Calcium (mg)	339.0	357.0
Other vegetables	29 ± 2.2	27 ± 2.2	Iron (mg)	22.4	24.8
Roots and tubers	27 ± 1.6	23 ± 1.6	Vitamin A (μg) (beta-carotene)	1000	1061
Milk	82 ± 5.0	82 ± 5.2	Thiamin (μg)	1456	1615
Fats and oils	12 ± 0.6	12 ± 0.7	Riboflavin (μg)	776	851
Sugar/ jaggery	5 ± 0.5	5 ± 0.5	Niacin (mg)	14.0	15.5
			Vitamin C (mg)	21.0	20.0
			Folic acid (μg)	64.0	70.0

From NNMB Report: Number within brackets indicates number studied.

Table 13

Energy and Protein Intake by Males and Females of Different Age Groups

Age group	Energy, kcal/d				Protein, g/d			
	RDA		Intake		RDA		Intake	
	Female	Male	Female	Male	Female	Male	Female	Male
Children:								
1-3 yrs	1050	1200	773	780	22.5	23.5	21.9	22.0
4-6 yrs	1500	1700	1097	1112	28.5	30.0	30.9	31.5
7-9 yrs	1800	2050	1320	1325	43.0	43.0	36.0	39.0
10-12 yrs	1950	2150	1483	1550	62.0	59.0	41.0	42.9
Adolescents:								
13-15 yrs	2050	2400	1620	1773	65.0	76.0	42.9	49.1
16-18 yrs	2050	2600	1721	1937	66.0	81.0	47.7	58.6
Adults (sedentary)	1800	2350	1789	2169	50.0	60.0	50.4	62.0

Intake based on NNMB survey in 10 states, 1975-80.

Table 14

Mean Calorie Intake (% RDA) by Age Group and Sex According to per Capita Income (Rural)

Monthly income (Rs)	< 30		30-60		60-90		90-150		> 150	
Age group	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Preschool:										
1-4 yrs	62.3	63.8	60.1	64.4	71.4	66.6	72.2	72.1	86.4	88.7
School age:										
4-7 yrs	73.3	73.3	68.5	72.4	73.6	70.4	77.2	78.5	91.3	88.2
7-9 yrs	72.8	74.5	71.2	69.5	71.9	72.5	76.2	78.8	81.8	82.8
10-12 yrs	72.1	75.6	69.9	68.9	65.4	73.0	70.8	79.8	85.7	85.9
Adolescents:										
13-15 yrs	73.5	67.4	70.3	64.3	77.2	69.8	74.2	73.3	94.0	86.8
16-18 yrs	77.8	70.8	71.7	67.9	72.9	64.7	78.5	69.6	84.8	86.1
Adults:										
18-50 yrs	90.3	88.1	86.6	84.1	88.0	84.1	91.7	89.5	101.5	96.5

NNMB Rural survey: States pooled 1975-80.

Table 15

Sex Differences in Iron and Vitamin A Intakes

Age and sex groups	Iron (mg/day)		Vitamin A (μg/day)	
	RDA	Intake	RDA	Intake
Children: 1-3 yrs	12	10.4	400	149
4-6 yrs	18	15.8	400	161
7-9 yrs	25	18.6	600	154
10-12 yrs	25	21.6	600	185
Adolescents:				
13-15 yrs Girls	43	22.4	600	194
–do– Boys	28	24.5	600	238
16-18 yrs Girls	50	23.7	600	242
–do– Boys	50	28.7	600	244
Adults: Women	30	25.0	600	236
Men	28	31.6	600	276

Table 16

Percent Distribution of 1-5 Year Children by Sex According to Gomez' Classification

Body wt. as % of standard	Nutrition Group: Normal ≥ 90		Mild 75-90		Moderate 60-75		Severe ≤ 60	
Group	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
Rural	20.1	9.6	51.3	44.6	25.6	39.3	3.0	6.5
Urban: MIG	49.1	29.0	39.0	49.5	11.6	20.4	0.3	1.0
LIG	27.8	13.4	45.8	49.1	24.6	33.0	1.5	4.5
IL	24.8	15.7	46.3	46.	26.4	34.4	2.5	3.9
Slum	19.4	9.0	46.1	39.1	31.1	42.5	3.4	9.4

NNMB survey 1975-80, states pooled.

Table 17

Percent Prevalence of Vitamin A and B-complex Deficiencies at Different Ages in Urban and Rural Areas

Social group/ Age	Vitamin A deficiency			B-complex deficiency		
	5-12 yr	12-21 yr	> 21 yr	5-12 yr	12-21 yr	> 21 yr
Rural: Female	7.0	4.0	2.8	11.4	6.0	3.7
Male	13.2	6.2	3.3	11.1	8.1	2.8
Urban: HIG: Female	2.0	–	0	3.0	1.8	0.4
Male	0	1.2	0.3	1.2	2.5	0.7
MIG: Female	4.0	1.0	0.2	4.2	1.4	1.6
Male	4.7	0.9	0.6	6.5	2.5	1.1
LIG: Female	3.0	3.0	1.0	4.2	4.2	3.6
Male	4.1	3.7	0.6	7.9	5.9	2.7
IL: Female	4.9	2.1	0.5	6.8	4.7	2.6
Male	6.8	5.8	1.6	7.1	5.4	2.7
Slum: Female	4.9	2.7	1.3	13.9	8.5	5.8
Male	7.8	6.0	2.1	15.3	13.2	5.4

Table 18

Percent Prevalence of Anaemia by Age and Sex

Age (yrs)	Hyderabad (Rural)		Calcutta (Rural)		New Delhi (Rural)		Madras (Urban)	
	Female	Male	Female	Male	Female	Male	Female	Male
1-5	65.9		95.4		59.0		21.2	
6-14	65.3	55.0	97.0	96.1	69.4	72.4	15.4	12.3
15-24	69.2	38.8	96.7	90.1	63.5	65.1	20.7	9.9
25-44	71.4	30.1	96.5	88.6	71.3	57.3	29.1	3.3
>44	47.6		92.4		59.3		18.8	

Table 19

Average Intake of Foodstuffs (gm) and Nutrients in Different States

State	Cereals & millets	Pulses	Leafy veg.	Other veg.	Roots & tubers	Nuts & oilseeds	Fruits	Fish	Other flesh foods	Milk	Fats & oils	Sugar & jaggery
Kerala[a]	302	12	2	60	121	49	10	33	1	36	3	17
Tamil Nadu[a]	437	33	5	50	41	8	19	9	5	78	10	17
Karnataka[a]	566	42	8	33	22	10	5	2	1	78	6	26
Andhra Pradesh[a]	505	24	8	33	27	3	20	7	6	87	12	9
Maharashtra[a]	420	34	10	41	16	3	15	4	2	75	12	27
Gujarat[a]	362	28	4	45	39	2	20	1	1	178	19	33
Madhya Pradesh[a]	407	43	5	34	34	*	12	*	1	82	10	19
Orissa[a]	537	55	26	77	53	1	23	9	2	12	6	6
West Bengal[a]	480	19	34	83	82	*	7	11	3	35	6	11
Uttar Pradesh[a]	433	30	10	44	66	*	8	2	3	54	3	7
Punjab[b]	435	27	50	34	70	NA	1	–11	–	348	15	76
Rajasthan[b]	404	44	14	15	18	NA	–	–*	–	178	6	19
Haryana[b]	470	33	29	26	46	NA	*	– 6	–	336	14	53
Jammu & Kashmir[b]	460	29	51	62	39	NA	8	– 5	–	117	8	6
Bihar[b]	423	27	23	48	94	NA	8	– 4	–	40	6	7
ICMR Balanced diet for Ref. Woman	440	45	100	40	50	–	–	–	150	25	20	

a: NNNB Rural survey, 1975-80, per CU

b: Food & Nutrition Board Survey, 1973-85 per capita consumption

**: Less than 1 g.*

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Table 20

Mean Intakes (% RDA) of Energy and Proteins by Indian Women and Girls at Different Ages and in Different States

States	Energy							Protein						
	Preschool		School age		Adolescent		Adult	Preschool		School age		Adolescent		Adult
	1-3	4-6	7-9	10-12	13-15	16-18		1-3	4-6	7-9	10-12	13-15	16-18	
Kerala	52.5	55.9	57.8	55.8	64.3	64.2	77.1	64.0	72.3	58.2	45.1	49.3	49.0	68.4
Tamil Nadu	79.0	65.6	71.2	79.9	80.8	87.8	96.6	105.1	89.8	79.8	55.6	66.7	68.9	87.6
Karnataka	89.5	90.6	90.5	99.7	104.2	107.3	129.6	113.4	129.7	100.5	85.6	87.1	84.2	127.2
Andhra Pradesh	71.5	71.4	71.8	71.1	75.2	83.3	99.9	85.4	97.0	78.3	56.5	58.7	71.6	90.2
Maharashtra	65.5	76.8	76.3	77.0	76.7	77.6	100.0	86.0	120.0	89.8	70.6	73.1	68.4	106.6
Gujarat	83.5	78.6	68.7	90.5	83.3	80.2	97.1	108.7	113.6	79.7	65.7	75.9	69.8	99.0
Madhya Pradesh	86.6	69.6	77.3	69.9	78.6	83.1	98.7	135.6	115.7	103.5	68.5	80.1	84.1	114.6
Orissa	63.2	65.1	74.4	71.3	76.3	92.5	–	75.6	84.4	74.1	51.2	57.0	72.1	–
West Bengal	63.9	69.4	65.7	65.1	72.1	76.4	88.6	86.0	103.7	76.8	55.8	60.5	62.5	66.8
Uttar Pradesh	58.6	63.5	61.1	71.4	65.5	88.6	96.2	96.2	116.5	90.1	73.7	66.7	96.1	114.8

NNMB Rural Survey 1975-80.

Table 21

Iron and Vitamin A Intake of Indian Women and Girls in Different States

States	Iron (mg/day)				Vitamin A (μg/d)			
	Preschool child	13-16 yr girls	16-18 yr girls	Adult women (sedentary)	Preschool child	13-16 yr girls	16-18 yr girls	Adult women (sedentary)
Kerala	5.6	15.8	15.0	14.8	95	126	134	133
Tamil Nadu	10.6	22.2	23.4	22.5	133	127	208	177
Karnataka	13.9	32.7	34.2	37.2	128	156	271	225
Andhra Pradesh	7.7	19.7	26.8	20.6	110	180	138	200
Maharashtra	9.5	24.5	26.8	28.5	115	248	274	273
Gujarat	10.0	22.2	20.5	21.2	220	238	449	340
Madhya Pradesh	12.3	21.9	24.4	23.9	123	109	152	134
Orissa	11.5	–	–	–	–	–	–	–
West Bengal	10.0	20.2	19.3	23.7	253	353	377	445
Uttar Pradesh	15.0	18.5	24.3	25.1	154	140	111	225
RDA	15.0	28.0	30.0	30.0	400	600	600	600

NNMB Rural Survey (1975-80)

Table 22

Preschool Girls (1-5 yrs) According to Gomez' Classification in Different States

State/	Body wt.deficit			
	Normal ≥ 90	Mild 75-90	Moderate 60-75	Severe < 60
Kerala	21.7	48.9	26.2	3.3
Tamil Nadu	17.4	48.6	29.5	4.6
Karnataka	13.7	46.3	36.1	7.0
Andhra Pradesh	16.8	47.6	30.1	5.5
Maharashtra	11.9	42.6	37.2	8.4
Gujarat	13.5	40.0	38.5	8.0
Madhya Pradesh	16.7	40.1	33.9	9.2
Orissa	20.7	45.6	26.9	6.7
West Bengal	14.1	48.0	32.0	5.0
Uttar Pradesh	19.1	48.0	27.0	5.9

NNMB Rural Survey (1975-80)

Table 23

Comparison of Body Weights (kg) of Indian Girls and Women at Different Time Points

Groups	Age (yrs)	All India survey (rural)		Tamil Nadu survey (rural)	
		1955-65[a]	1975-80[b]	1954[c]	1980[b]
Infants	0-1	5.63	5.80	–	–
Children	1	7.70	7.54	–	–
	2	9.30	9.14	–	–
	3	10.90	10.62	–	–
	4	12.50	12.09	–	–
	5	13.90	13.72	12.8	13.7
	6	15.40	14.88	14.4	14.6
	7-9	18.93	18.30	17.4	17.9
Adolescents	10-12	24.76	24.60	22.9	24.0
	13-15	33.17	34.70	25.8	30.0
	16-18	33.93	41.10	–	–
Adults	18-91	41.83	42.50	–	–

a: ICMR Growth Studies, 1955-1965
b: NNMB Rural Survey, 1975-1980
c: Nutrition Work in States, Madras, 1954

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Pattern Of Growth And Development Of Indian Girls And Body Size Of Adult Indian Women

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Growth and physical development of infants and children and body size of adults are widely used as indicators of the overall health and nutritional status of a community. When data on these aspects are collected periodically and interpreted carefully, they can serve as pointers to changing health status and can therefore be used to monitor the impact of developmental and health programmes.

In India, collection of data on the growth and development of children dates back to almost five decades. Early attempts, however, were sporadic and the reliability of data somewhat suspect, because the tools used were not always standardised, ages of subjects not accurately recorded and samples frequently not representative. To overcome these deficiencies and to determine the factors which influence growth, the Indian Council of Medical Research (ICMR) initiated a nation-wide cross-sectional study in 1956 and over a 10-year period collected data on over 127,000 subjects[64]. The results of these studies were published in 1972. A serious limitation of this study, however, was the fact that the data could not be considered as 'standards', since the sample studied was heterogenous, including as it did, children from all socio-economic strata from both urban and rural parts of the country. They represented therefore community averages and not true standards. In recent years, there have been some studies [16,51,52,67,68] on the growth and development of children coming from the well-to-do segments of the population and these data may perhaps be considered as representing current 'standards' i.e. levels of growth achieved by population segments relatively free from environmental constraints on growth.

While there is a good deal of information on the heights and weights of

children in our country, data on the body size of adults are surprisingly limited. Even today, there are no recommended 'standards' for anthropometric measurements of adult men and women. Data collected and reported by the National Nutrition Monitoring Bureau (NNMB) since 1973 have, to some extent, remedied the situation, because information is now available on the heights and weights of fairly large numbers of rural adults in 10 states of the country[42]. Such data on urban populations and the well-do-do is, however, still scarce.

In a country as diverse as ours with respect to food habits, as well as availability and utilisation of health and medical services, regional variations in the growth and development, particularly of young children and body weights of adults, are to be expected. If such variations are significant it would become necessary to take them into consideration in the interpretation of regional data in the context of national standards. Recent studies have provided some information on this aspect. Also, in a country where malnutrition is of public health magnitude and contributes substantially to mortality and morbidity, it becomes necessary to determine its effect on growth and development during early childhood as also the growth status of the survivors of moderate and severe malnutrition, since it is known that chronic malnutrition can have functional and socio-economic repercussions on adult life.

A secular trend in growth had been found in many developed and some developing countries. The improved heights and weights of successive generations has been attributed, in part, to better standards of living which include better food and better environment. Data on secular trends in our country have not been collected systematically, but there are observations made over a time span from which some conclusions can be drawn.

Though malnutrition affects all segments of the population, women and children appear to be more at risk than are others; also, the consequences of malnutrition appear to be more serious. There is, in addition, the belief that culturally determined social behaviour places the woman and the female child at a nutritional disadvantage. This belief has gained wide acceptance without its having been subjected to adequate scientific scrutiny. Some recent studies which have specifically looked into this aspect seem to question the validity of this belief.

In this section, the empahsis is on the growth and development of the Indian female. Published data on the growth of the Indian female from birth to adulthood are reviewed and the relationships between growth and socio-economic variables examined. Gender bias, when present, has been highligh-

ted and secular trends, if any, pointed out. In many publications, particularly those dealing with infancy, data on the two sexes have not been presented separately. When these data have been used, it has been done so assuming that sex differences were either absent or if present, they were minimal. No attempt has been made to cover all published data.

Although the use of a large number of anthropometric requirements has been suggested to assess growth status, height, weight and indices derived from these two, arm-circumference and skin-fold thickness are the most frequently employed. It has in fact been shown through step-up and step-down regressions, that the information provided by the first two measurements – height and weight — improves only marginally by the inclusion of one or more of a large number of additional measurements of choice in most reported studies.

Birth weights: There is a large volume of data on the birth weights of Indian children (Table 1). While some workers have reported the mean weights of male and female infants separately, a great majority have presented pooled values. Marked socio-economic differentials in birth weights have been repeatedly reported. Almost four decades ago, it had been observed that the birth weight of South Indian infants born to mothers belonging to the higher socio-economic strata was 3100g or more as compared to between 2700g and 2800g for infants born to mothers of the lower socio-economic groups [1,17,18,66]. This differential has been found consistently.There does appear to be a sex difference in mean birth weights – female infants tending to be lighter than male infants, irrespective of socio-economic status. In a large series of hospital-born Delhi infants the mean birth weight of female infants was 85g lower than that of male infants[16]. Other workers have found differences ranging from 50g to 100g [4,10,14,25]. Among the well-to-do, weight difference between the sexes appears to be more pronounced, ranging from 100g to 300g [11,65]. Urban-rural differences in mean birth weights seem to be inconsistent. While in Hyderabad and in Ootacamund no differences were seen[26,56], significant differences of over 100g have been reported from parts of Tamil Nadu [54]. In fact, in this study, urban female infants were heavier than even the rural male infants (2820 g vs. 2750g).

The frequency distribution of female infants according to birth weights seems to be somewhat different from that of male infants. A higher proportion of female infants – 26 percent — had weights under 2500g than did males (20 percent) while a smaller proportion of female infants (four percent) had weights exceeding 3500g, than did males (6.7 percent)[16]. These differences, however, were found not to be associated with higher early neonatal, perinatal or infant mortality rates[16,26].

Income and a host of maternal factors such as literacy status, height, weight, haemoglobin levels and antenatal care have all been repeatedly found to influence birth weights. In no study are data presented separately for the two sexes on these aspects, but there is no reason to suspect that the sex of the infant would have mattered.

Even within the low income groups, a gradient in birth weight is evident with rising incomes, there being a 100-150 g difference between the poorest and the less-poor[16,34]. Differences of a similar magnitude have been recorded for infants born to anaemic and non-anaemic mothers, as also for infants born to illiterate and up-to-high school-educated mothers[16]. There are also reports that maternal anaemia does not lower birth weights [31]. With increasing maternal height from below 145 cm to above 160 cm, differences in birth weights are of the order of 200 to 400g. Similarly, with increasing maternal weights from around 35 kg to over 55 kg, differences in birth weights are of the magnitude of 100g to 250g [16,39,46]. In another study provision of antenatal care during the second trimester made a difference of 150g to birth weights while similar antenatal care given only during the third trimester made a smaller difference of less than 100g[27]. Interpregnancy interval seems to make a difference in birth weights by about 200g, only when it is shorter than 12 months[16,37,54].

In a small series of young women whose nutritional antecedents were known from the time they were of preschool age, it has been observed that even those who were severely malnourished and had recovered from either kwashiorkor or marasmus, delivered babies with a mean birth weight of 2410g as compared to mean birth weights of 2570g, 2550g and 2620g of infants born to the mild, moderately malnourished and normal mothers [28].

Neither the mean birth weights nor the proportion of infants with birth weights under 2500g reported in recent years, appear to be different from those reported over three decades ago – an observation which fits into the general finding that the nutritional status of large sections of Indian pregnant women belonging to the poor-income groups has changed little, judging from either their dietary intakes or anthropometric measurements. The prevalence of anaemia too seems not to have altered much.

Growth and development during infancy: Data collected in the ICMR cross-sectional study show that Indian female infants more than double their birth weights by the age of six months, but that the subsequent growth rate is much slower[64]. At the age of one year (nine months +) they weighed 6.6 kg – a weight which is 800g less than the weight of male infants. At age 12+ months, female infants were found to have a mean weight of 7.8 kg. Recent longitudinal data reported for infants studied at Delhi provide essentially similar infor-

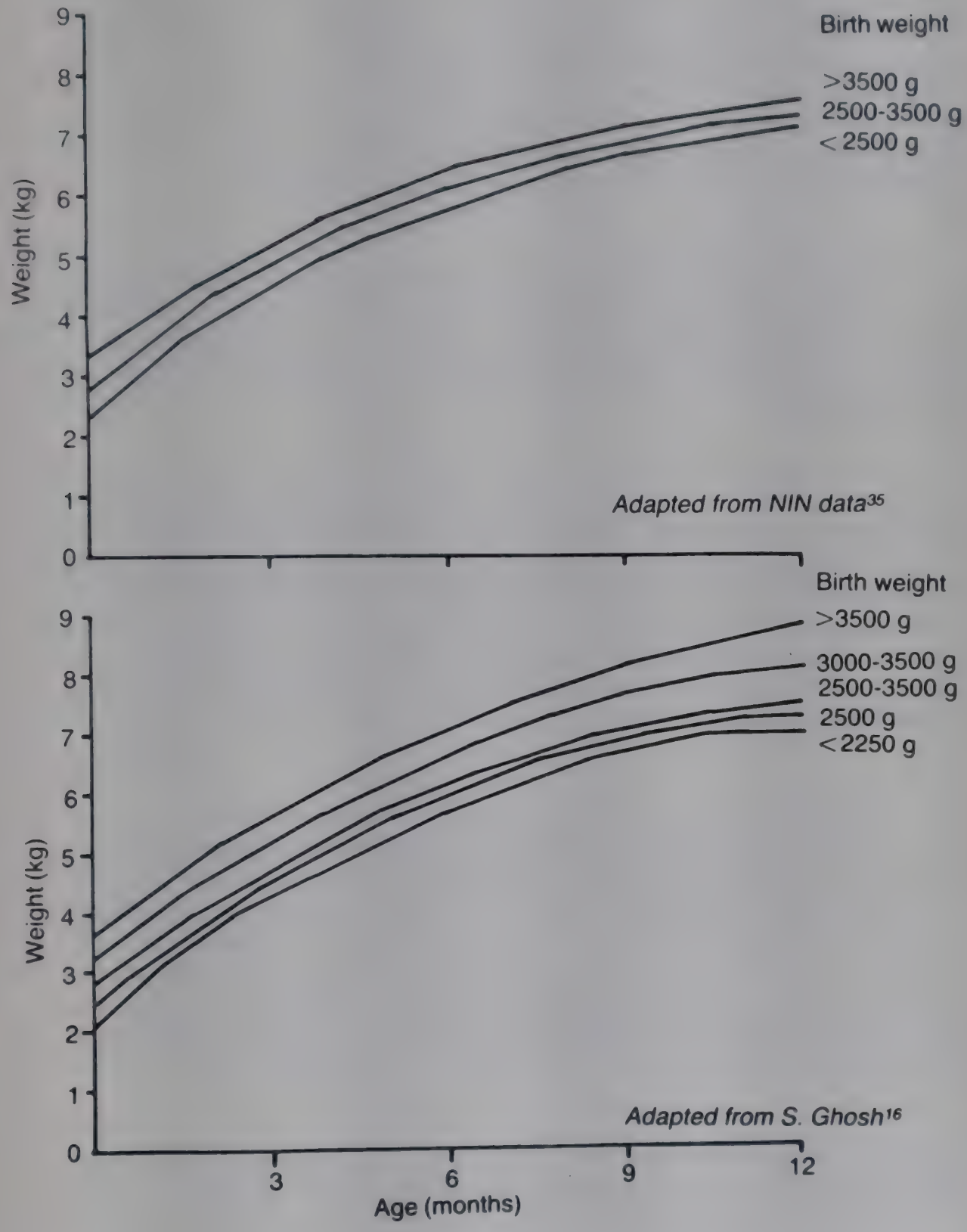
mation – a doubling of birth weight at six months and a tripling at 12 months after birth [16]. The mean body weight at 12 months in the Delhi study was 7.8 kg – a value much higher than that seen in the ICMR cross-sectional investigation. This comparison, however, may not be strictly valid since the ICMR data pertain to infants aged between nine and 12 months and would, therefore, have included an unknown number of infants less than 12 months old. In a series of studies reported from Hyderabad over the last decade, body weights of infants at 12 months of age has been found to be between 7.2 and 7.9 kg. This is for both sexes together and no effort has been made to provide data separately for boys and girls.

Results of some longitudinal studies have provided some insights into the influence of birth weight on subsequent growth during infancy among infants belonging to the poor socio-economic groups[16,29,35]. Infants with very low birth weights, below 2000g, invariably grew at a rate much faster than did infants with higher birth weights and at six months of age, differences had narrowed down considerably. As a group, infants whose birth weights were less than 2500g weighed 599g less at one year of age, as compared to infants whose birth weights were above 2500g. Infants who had birth weights of over 3500g had markedly higher body weights at the age of one year[16]. It is, however, significant that despite these differences in absolute weights at the age of one year, the increments over the 12-month period were largely independent of birth weight. Among Delhi infants increments ranged from 4.9 to 5.2 kg while among infants studied at Hyderabad, it varied from 4.3 to 4.8 kg [35]. Growth velocities therefore appeared to be similar in infants of differing birth weights (above 2000g) and much of the differences in body weights seen at the age of 12 months, simply reflected differences in weight at birth (Figure 1).

Regional variations in body weights of girls at the age of nine + and 12 + months seem to be of a small order. At nine+ months mean body weights were within the narrow range of 6.3 and 6.6 kg in Andhra Pradesh, Delhi, Jammu and Kashmir, Madhya Pradesh, Madras, Maharashtra, Orissa, Punjab and Rajasthan. In two states – Kerala and Utttar Pradesh — however, values looked higher, being 7.0 and 7.2 kg respectively. Both at nine and 12 months, urban and rural girl infants had essentially similar mean body weights – an observation somewhat different from that in boys – urban boys tending to be heavier than rural boys of corresponding ages[64].

More recent data also show that at the age of 12 months, there are no urban-rural differences in body weights of infants who are solely breast fed[29]. However, among rural infants who had been started on supplementary foods, weights were about 500g less than that of urban infants (7.4 vs. 7.9 kg), though at the age of nine months these differences were not seen. It has also

Fig. 1. Effect of Birth Weight on Growth During Infancy



been reported that mean weights of rural infants who received food supplements within the first three months of life were lower than that of infants solely breast fed (4.39 vs. 4.87 kg), but that this 0.5 kg difference had disappeared at 12 months (7.26 vs. 7.41 kg)[30,32]. This observation is somewhat different from that reported on urban infants in whom body weights of supplemented infants was higher than those of solely breast fed infants at 12 months of age. The absence of differences in body weights of supplemented and solely breast fed infants in the rural areas has been ascribed to the higher morbidity load, likely to have been experienced by those who had received additional supplements. No supporting data have, however, been presented.

The growth rate of infants breast fed by women taking oral contraceptives from the sixth month of lactation was found to be in no way different from that of infants whose mothers were not on oral contraceptives[33]. At 12 months of age, the two groups of infants had mean weights of 9.67 and 9.84 kg respectively.

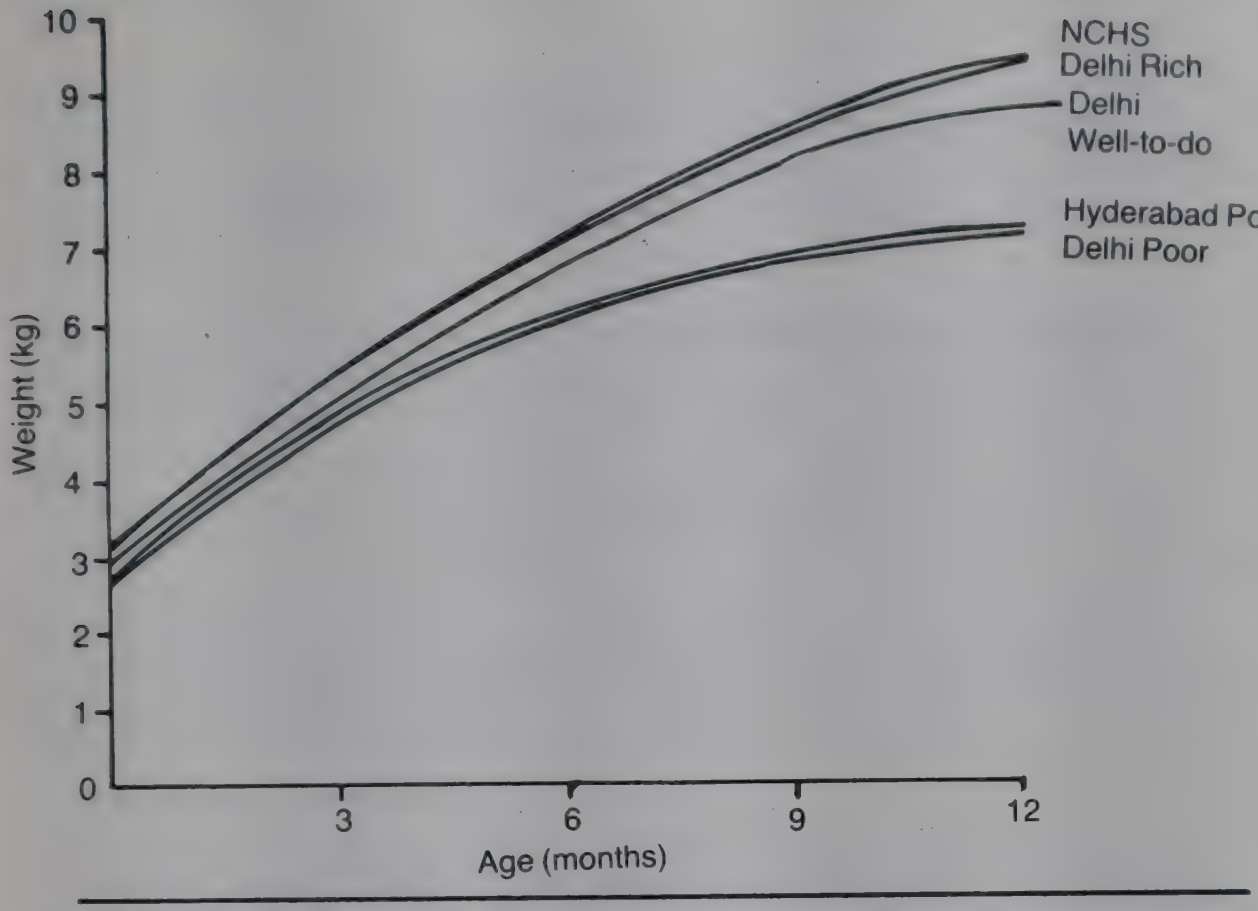
Comparisons have also been made on the growth performance of infants (irrespective of their birth weights) in relation to their mothers' height and weight, using 38 kg and 145 cm as the cut-off levels. The growth performance of infants born to mothers whose body weights were below 38 kg was marginally poorer than those of infants born to mothers whose body weights were above 38 kg, after between the third and six month of life. No such differences were, however, seen between infants born to mothers who had heights below and above 145 cm[45].

The growth pattern of well-to-do infants in India is very similar to that of the NCHS standard. In fact, the growth of infants born to parents in Delhi, whose per capita income was over Rs.1,000 per month (1970s) was identical with that of NCHS (Figure 2). A consistent finding about the growth of Indian infants is the observation that, irrespective of socio-economic status, the growth curve runs parallel to that of the NCHS standard, but that between the third and sixth months of life, growth of infants belonging to the poor income groups tends to flatten out and that by 12 months of age, the difference in body weight is as large as a kilogram or more.

Data available from published reports on birth weights of Indian infant girls and their growth during the first year of life, may be summarised as follows.

- There are some differences in the birth weights between male and female infants, female infants being slightly lighter. A higher proportion of

Fig. 2. Weights of Indian Infants: Birth to One Year



girls have birth weights below 2,500g. This, however, seems not to have much functional significance as judged by absence of differences both in morbidity and mortality.

• There is a well defined gradient in birth weights of infants born to the poor and the well-to-do mothers. Mean birth weights of the low socio-economic groups which were around 2,700g three decades ago, have changed little even now.

• There are no striking differences in the mean birth weights of poor rural and urban populations.

• Birth weights seem to influence subsequent growth during the first three to six months, when they are below 2,000g. In infants with birth weights between 2,000g and 3,500g, absolute gains in weight over a 12-month period seem to be independent of birth weight.Thus, at the age of one year, differences in weight seen at birth are maintained. Infants with birth weights over 3,500g show higher growth velocity.

• Growth rates are not strongly influenced by the early introduction of supplements in rural areas unlike in the urban areas, where infants who received supplements grew better than those solely breast fed.

•Whether there are marked regional variations in birth weights is not clear. Since both maternal height and weight as also her haemoglobin level does influence birth weights, whatever regional differences there may be can perhaps be attributed to regional variations in these maternal attributes.

Psychomotor development: Studies on psychomotor development of Indian children are of relatively recent origin. It was first reported by Phatak [49] in 1970 that infants born to mothers belonging to the upper middle class were able to perform 50 percent of motor tasks and 35 percent of mental tasks at an earlier age, than did American infants. Data for the two sexes have, however, not been given separately. That the developmental milestones of Indian infants – particularly those related to psychomotor activity — were ahead of western infants has also been reported by Veena Patel[47]. This study has also reported that urban infants did better than did rural infants in motor, personal, social and language development, but that urban infants were behind the rural ones in adaptive behaviour. In a large series of Indian infants – both urban and rural – it has been confirmed that neck-holding, crawling and pointing out to objects are seen at an earlier age than among western infants, there being no sex differences[36]. In a longitudinal study of urban infants in Calcutta[6] belonging to the economically well-to-do classes, this earlier motor development and adaptive, social and personal development as compared to the Western infants has been seen up to the age of three months, but similar at the age of one year. Indian girl infants did several of the motor tasks a little later – two to four weeks than did boy infants – a difference which was no longer seen at age 12 months, except for language development, in which males did better than females[21]. This observation is somewhat contrary to the generally held belief that language skills develop earlier in girl infants. There are some reports that infants girls tend to lag behind boys in motor skills too.

Birth weight seems to influence psychomotor development – there being a two- to six-week difference between infants with low birth weight and normal birth weight [2,7,19,63]. In a longitudinal study, involving several thousand infants, sitting, crawling, and walking without support have all been found to be delayed when birth weights are below 2,100g[16]. No delay was seen with respect to speaking monosyllables. Unfortunately in this extensive study, data for the sexes have not been given separately.

Information on the developmental milestones of tribal children is scanty. Recent studies among tribal infants in parts of Calcutta and Jabalpur [44] have

shown that a higher proportion of tribal infants had delayed turning over as compared to their rural and urban counterparts, but learnt to walk earlier. There were no differences with respect to standing without support and language development.

It would thus seem that psychomotor development of Indian infants is ahead of that of western infants and that birth weight as well as body weight during infancy influences this development. Whether there is a sex difference in psychomotor development during the first six to 12 months of life is not clear. Apart from body weight, economic status, maternal educational level and family size have also been implicated in determining the pattern of development[8]. The precise contribution of each of the factors does not seem to have been worked out.

Growth Of Preschool Children

The group of children aged between one and five years has been one of the most extensively studied segments of the Indian population with respect to growth status.

The cross-sectional study reported by the ICMR[64] shows that for Indian girls as a whole, the mean weight was 7.7 kg at age one+. Regional variations were, however, seen: weights ranging from a low 7.3 kg in Rajasthan to a high 8.7 kg in Delhi. In a majority of states, however, body weights fluctuated within the narrow range of 7.5 and 7.9 kg.

At age five+, the mean body weight of Indian girls had increased to 14.3 kg. Here too, regional variations were observed, from a low 13.9 in Kerala to a high 16.0 kg in Delhi. The mean absolute gain in weight between the first and fifth years of life was thus 6.6 kg, the variation in the different states being anywhere from 5.8 to 8.3 kg. The differences in gain in weight at age five+ seemed not to be related to body weight at age one+.

The mean height of Indian girls as a whole, at age one+ was 72.4 cm. Regional variations were seen, but were much less marked than those in weight. Girls in Rajasthan were the shortest at 71.8 cm and girls in Delhi the tallest at 74.2 cm. At age five+ the average Indian girl had a mean height of 101.3 cm, thus registering a gain of 28.9 cm. Regional variations seen in mean heights at age one+ persisted at age five+. Girls from Orissa were the tallest with 106.9 cm and girls from Madras the shortest at 100.4 cm. Absolute gains in height in the different states ranged from 26.0 cm to 33.6 cm – which is not an

inconsiderable difference. As in the case of weight, there appeared to be little relationship between height at age one+ and the extent of height gain at age five+.

Socio-economic status and income were found to be factors which clearly influenced heights and weights. Both measurements increased progressively as socio-economic status or income improved. In the lowest income groups, mean weight at age one+ was around 7.5 kg as compared to 8.5 kg in the upper income groups. Corresponding values at age five+ were 14.0 and 16.0 kg. Since increments in weights during the four-year period were greater in the high income groups, mean body weight differences were wider at age five+ than at age one+. This was true of mean heights as well. At extremes of income, there was a 3.5 cm difference in height at age one+ which had increased to 6.5 cm at age five+ (Figure 3). Mean absolute gain in heights between ages one+ and five+ was only 27.1 cm in the low income groups, as compared to 31.0 cm in the high income groups.

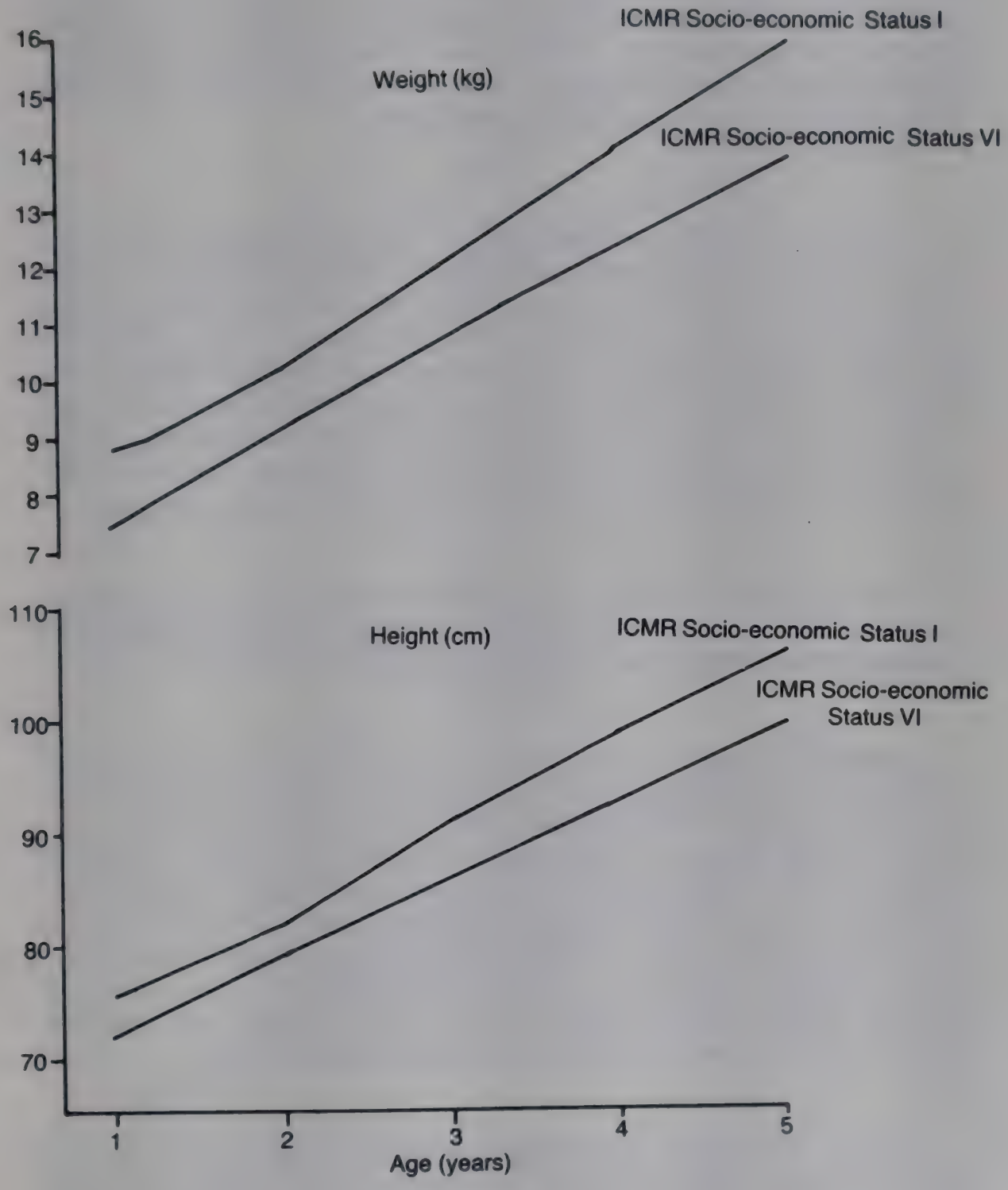
Comparison of data obtained when children were classified according to socio-economic status, with those when children were classified according to income status showed that there were hardly any differences. In the ICMR study socio-economic status was decided by just two considerations – income and occupation. The absence of differences in the growth status of children, when parental occupation was added as a variable to per capita income, suggests that the preponderent influence on growth was that of income.

The growth pattern of rural girls seems to be somewhat different from that of urban girls. While the mean birth weights as well as mean body weights at age one+ of rural and urban girls were found to be essentially similar, by age five+, urban girls were taller by 2.6 cm and heavier by 0.8 kg than their rural counterparts. The reasons for this trend are not clear. They may, however, be reflections of better feeding practices and better medical and health care facilities.

Tribal children form a distinct group in our country but studies on their growth pattern are few. It is only recently that some data on their heights and weights have become available through cross-sectional studies, particularly in parts of Calcutta and Jabalpur[44]. Mean heights and weights at ages one+ and five+, as also gains in weight and height between ages one+ and five+ of tribal girls, have been found to be very similar to those of both the rural and the urban poor.

It needs to be reemphasised that the pooled data available from the countrywide study reported by the ICMR, represent the heights and weights of the

Fig 3. Growth of Indian Girls between Ages 1 and 5: Effect of Socio-economic Status



'average' Indian girl and cannot, therefore, be used as standards to determine the growth potential. International standards have been widely employed to evaluate the growth status of Indian children in the past and continue to be used even now. This assumes that international standards are, in fact, applicable to Indian children. The need to determine the validity of the use of international standards to judge the growth performance of Indian children, therefore, acquires some importance. In recent years, attempts have been made to define standards for Indian children from birth to adulthood. For this purpose, heights and weights of subjects belonging to the high socio-economic strata have been collected. It has been assumed that since there were no obvious constraints on the full expression of the genetic potential for growth, data obtained would, indeed, represent optimal growth.

Data are available from three studies – two from Delhi and one from Hyderabad. In one of the studies from Delhi, a cohort of infants born to well-to-do families was followed up from birth to 10 years[16] while in the other, infants born to the high income groups were followed from birth to 14 years[11]. The study from Hyderabad is a cross-sectional one, in which children betweeen 18 and 60 months of age who came from very well-to-do families were included[52]. In addition, data are also available from the ICMR national cross-sectional study, separately for girls belonging to different socio-economic categories, including one designated as the highest socio-economic group.

Data from all these studies clearly show that both heights and weights of the well-to-do girls are well above those reported for the average Indian girls, reported by the ICMR (Figures 3,4, and 5, Table 2).

Weight: The mean weights of well-to-do girls both in Delhi and in Hyderabad, studied in the mid-'70s are quite close to those reported by the ICMR for the highest socio-economic group a decade earlier. All three, however, are lower than the NCHS values, but much higher than the pooled ICMR value. The pooled ICMR value was around the third centile of NCHS data, while that for the high socio-economic group of ICMR, was between the 10th and 20th centile values. Those for well-to-do Delhi and Hyderabad girls, fell at a somewhat higher level – between the 20th and 25th centile. In sharp contrast, values reported by Banik for the well-to-do Delhi girls coincided with NCHS values, and at age five actually somewhat higher.

Height: The mean heights of well-to-do Delhi and Hyderabad girls were similar and only marginally higher than weights of the ICMR high socio-economic group. All three, however, were lower than the NCHS values. However, deficits in heights of these Indian girls were lower than deficits in

Fig. 4. Growth of Indian Girls between Ages 1 and 5 Years : Weights

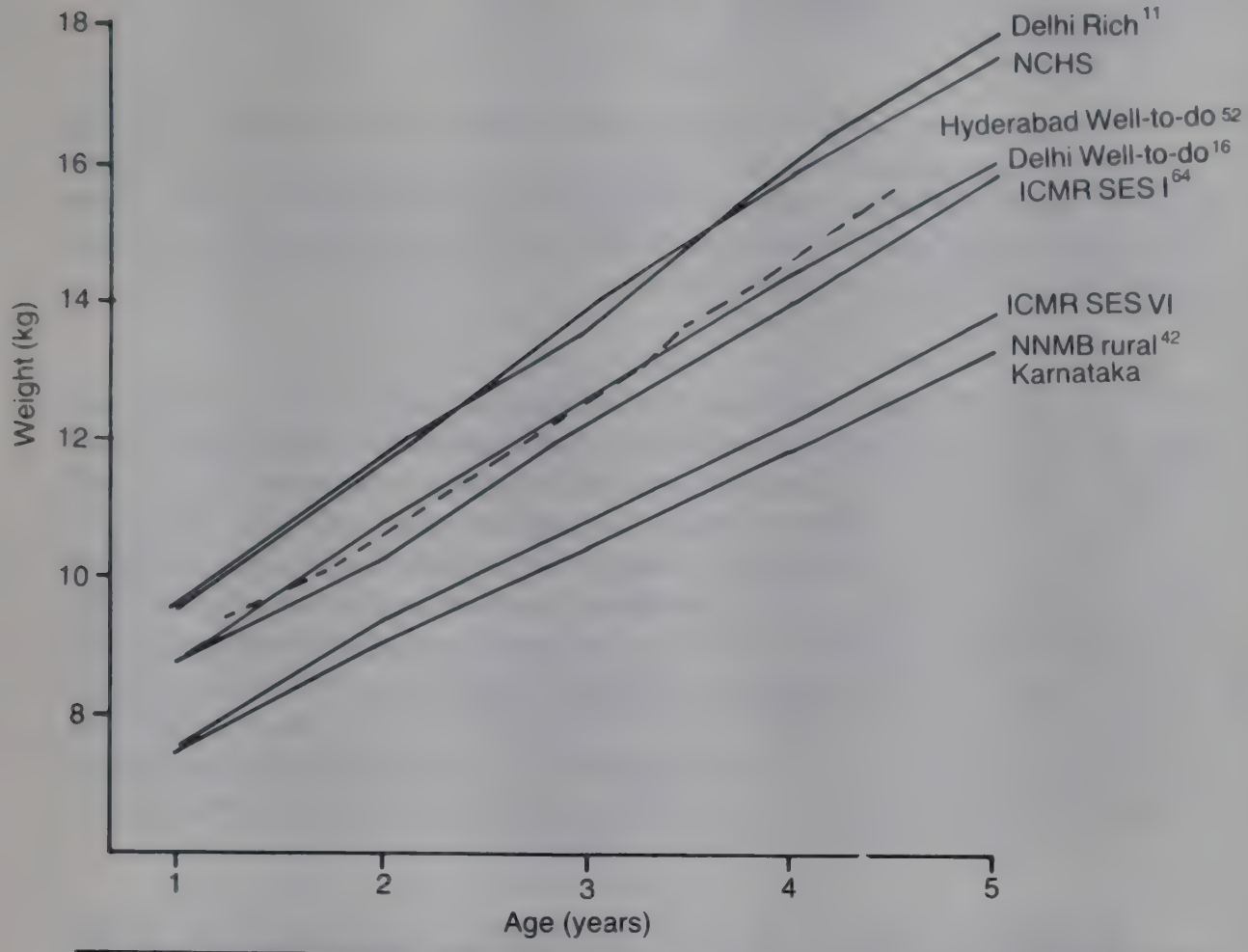
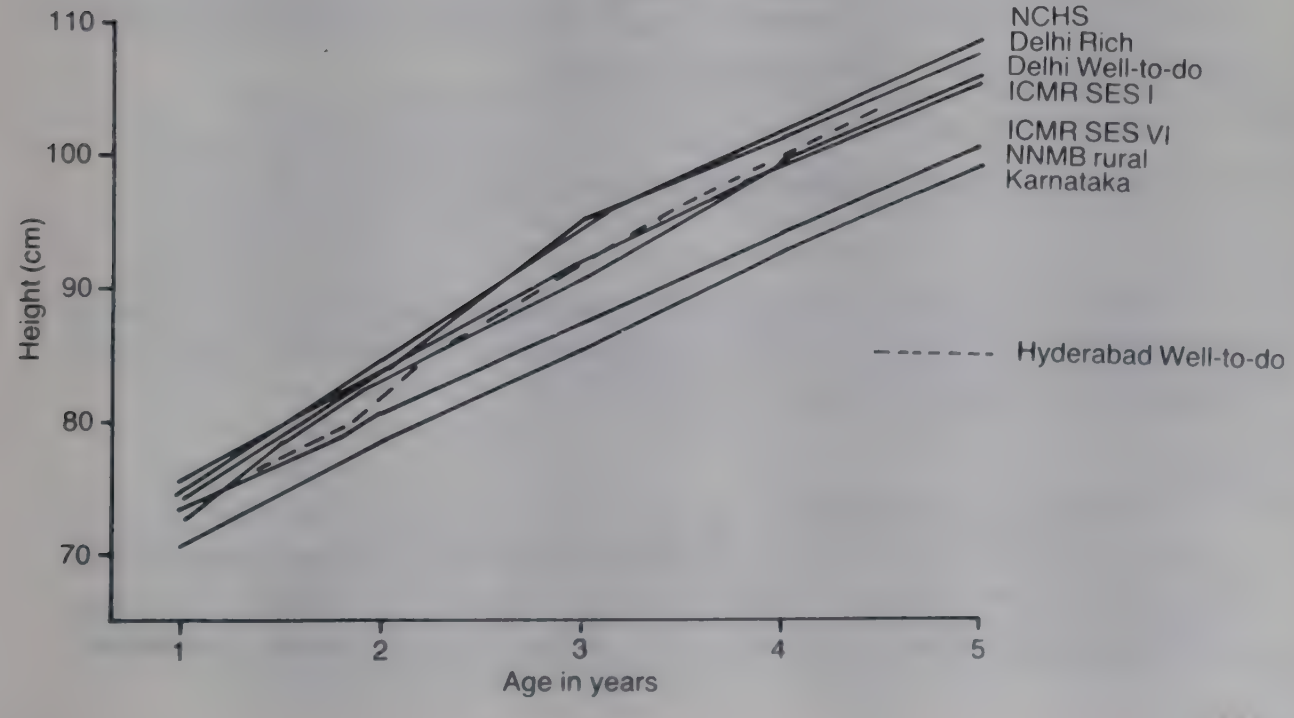


Fig. 5. Growth of Indian Girls Between Ages 1 and 5 years: Heights



weights. Thus, mean weights of the well-to-do Indian girls lay between the 20th and 30th centile of NCHS values, particularly after the age of two years. The heights of Delhi girls studied by Banik, however, corresponded to the 50th centile of NCHS standards.

This difference in the height and weight status of girls studied by Banik and others may probably be due to diferences in the type of children chosen for the study. Those studied by Banik belonged to families with higher incomes and while all the three sets of children belonged to the well-to-do category, the latter two were less affluent.

It is clear from these data that the average Indian girl coming from even the well-to-do family, falls short of the NCHS standards in both height and weight, more so with respect to weight. This acquires some importance in the validity of using the NCHS standards to compute the growth status of Indian girls, since it may overestimate the extent of growth retardation. Though it may be argued that data reported by Banik lends support to the use of NCHS standards, it may be prudent to carry out large scale studies in different parts of the country, on the growth status of girls who belong to the really affluent sections, who, right from infancy (if not from the intrauterine growth state) had no constraints of any kind on growth. Such data will help determine whether the NCHS standards are totally applicable to the Indian situation.

At practically all ages between one and five, the mean heights of the Indian well-to-do girls were found to be around 92 percent of the NCHS values, indicating thereby, that their growth during the period was uniform and that the absolute increments in weight between the first and fifth year of life was 90 percent of that of NCHS values. This value was much lower in the average Indian girls -- being around 80 percent.

Growth Of Indian Girls Between Ages Five And 10

The growth pattern of Indian girls of schoolgoing age between six and 10 are shown in the figures. Wide variations are seen both for weights and heights, depending upon socio-economic status.

The average Indian girl at age 10 has a mean weight of 23.6 kg and a mean height of 128.4 cm. Regional variations are seen, the range for weight being from a low 21.5 kg in Maharashtra to a high 26.0 kg in Delhi. The other states had mean values in between these, the order being Kerala, Rajasthan,

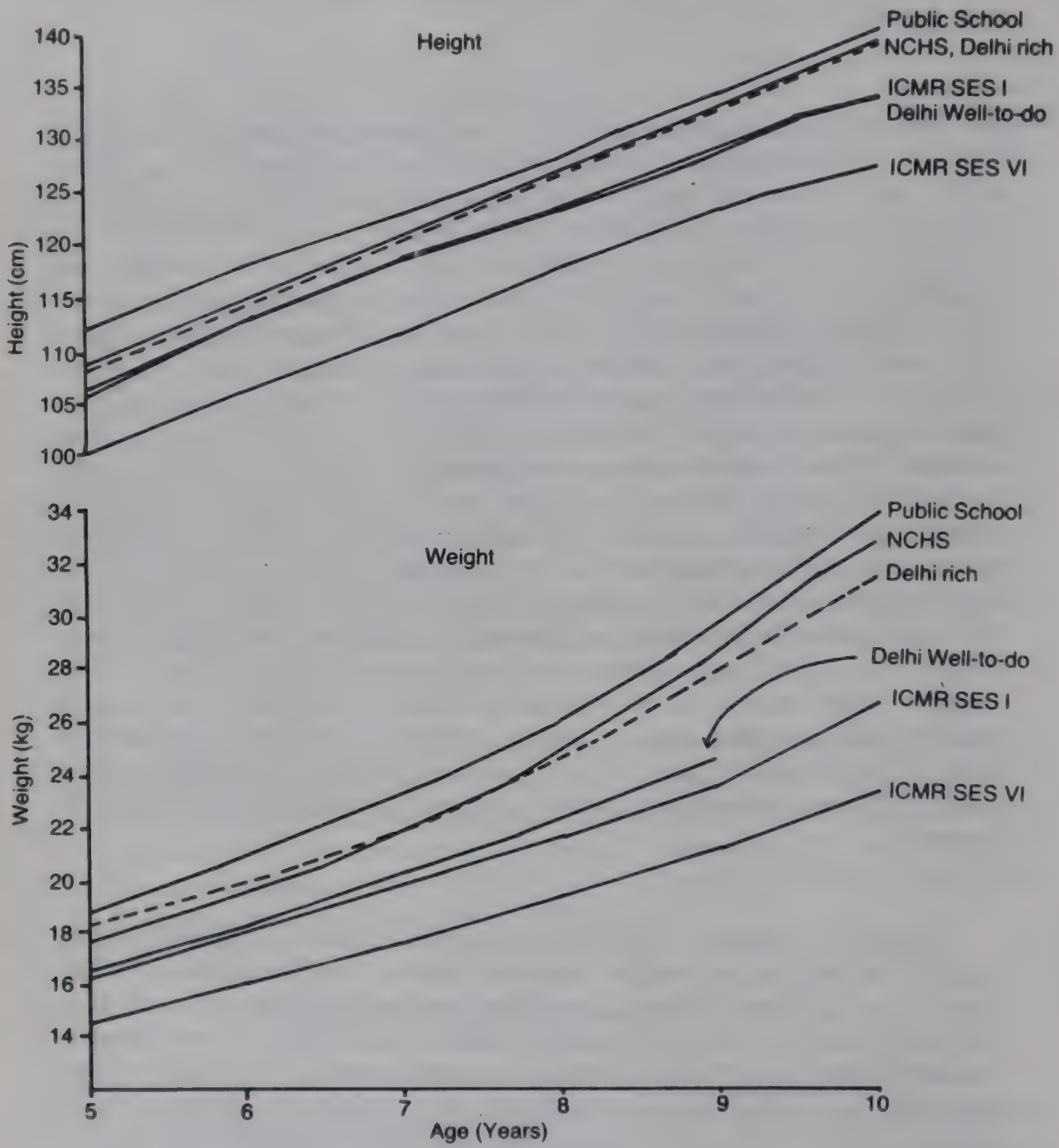
Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Madras, Orissa, Punjab, Jammu and Kashmir. Girls in Jammu and Kashmir were the tallest with a mean height of 132.6 cm, followed by Orissa, Delhi, Punjab, Madhya Pradesh, Rajasthan, Andhra Pradesh, Maharashtra, Madras. Kerala girls were the shortest, with a mean height of only 125.0 cm. The rank orders are also dissimilar to those for preschool girls.

Indian girls belonging to the highest socio-economic group of the ICMR study had a mean height of 132.5 cm and a mean weight of 26.7 kg. Unlike in the case of preschool age group of girls studied by Ghosh at Delhi[16], by the National Institute of Nutrition at Hyderabad[67] and by the ICMR in the National study[64] (high socio-economic status), wherein the heights and weights were close to one another, in the school age group, the three studies have provided differing sets of values. In all the three groups mean weights were much higher than that for the average Indian girl, but the values reported by the National Institute of Nutrition are considerably higher than those reported either by Ghosh or by the ICMR (Figure 6). In fact, those reported by the Institute are essentially similar to values reported by Banik for well-to-do Delhi girls and both these are marginally higher than the 50th centile of the NCHS standards. The girls studied by Ghosh in the two age groups came from a single cohort. On the other hand, those studied by the NIN did not belong to a homogeneous group. The preschool children came from well-to-do families living in Hyderabad, while the school children were drawn from 14 different residential schools located in different parts of the country, which catered to the educational needs of the elite. It is posssible that the socio-economic category and the 'elitism' to which the preschool children in Hyderabad and the children in the residential schools belonged, were dissimilar – the latter perhaps being more affluent than the former.

It must be considered significant that school children studied in Delhi by Banik[11] had heights and weights similar to those of the 50th centile of NCHS standards. All these children came from one geographical area and from essentially uniform very high socio-economic status. These observations of Banik in Delhi[11] and of children from public residential schools in the country, strongly suggest that Indian school girls are capable of achieving NCHS growth standards. They also suggest that if preschool children from different parts of the country are also drawn from the economic strata which matches that of the public school children, their growth status will, in all likelihood, be close to that of the NCHS standards. Such data obviously need to be generated, to confirm this possibility. Also, re-analyses of the pooled NIN data, regionwise, may be a useful exercise.

A comparison of the NCHS growth pattern of boys and girls in this age

Fig. 6. Growth of Indian Girls between Ages 5 to 10 Years



group clearly shows that between the ages of five and nine years, girls are lighter than boys of corresponding ages. But the differences become progressively less and are minimal at age nine. Between ages 10 and 13, girls are heavier than are boys and after this age, boys regain their heavier status. The data reported for children studied in the residential schools show the same trend, though the absolute differences, at each age, are not identical with those of the NCHS. Among the children studied by the ICMR, such a trend is seen in those belonging to the highest socio-economic status, but with a slight shift in the age at which the weight of girls overtook the weight of boys – it occurring almost two years later. In sharp contrast, in children belonging to the lowest socio-economic strata, this sex-linked trend was totally absent. All that could be seen was a tendency for the differences in weights of girls and boys to become minimal at around 13 years of age (Figure 7). At no point of time did the girls weigh more than the boys.

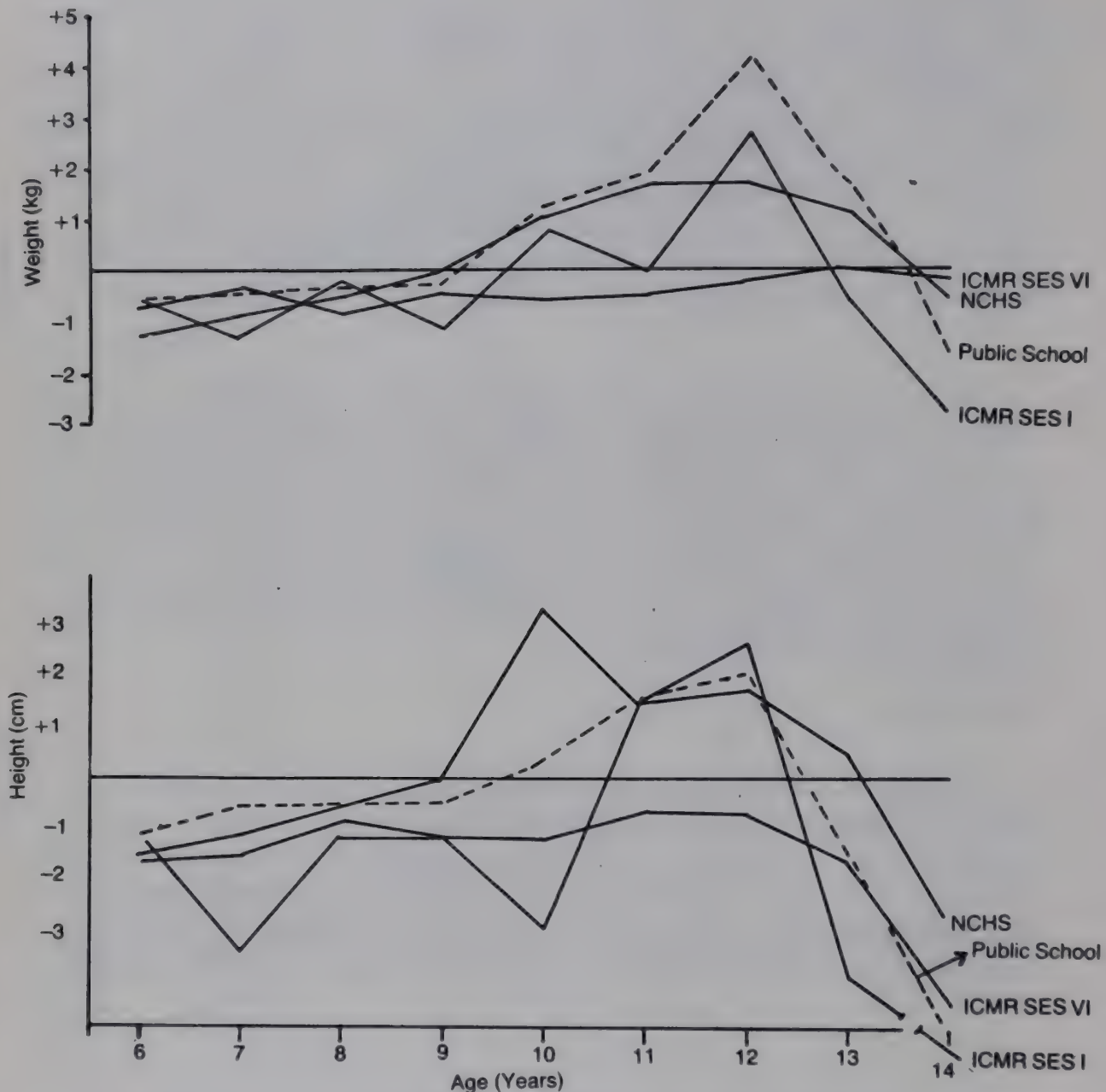
Observations with respect to weights were somewhat similar, but the variations between boys and girls at different ages seemed to be much more erratic. The reasons for the differential pattern of growth between the ages of five and 10 years are not clear. It could partly be due to a delay in the prepubertal growth spurt among the poorer socio-economic status (as will be seen later, menarche occurs at a later age in this group) as also partly due to a culturally determined discrimination against girls in the matter of nutritional and health care, particularly health care.

Absolute increments in weights of girls between ages five and 10, were also socio-economic dependent. Increments were lowest among the poorest groups (8.4 kg) and highest in the group attending the residential schools (14.9 kg). This value is identical with that for the NCHS growth standards. Somewhat surprisingly, the very well-to-do children studied by Banik did not quite match the NCHS standards – they gained only 13.1 kg over this time period.

Absolute increments in heights were also influenced by socio-economic status, but the differences were much less marked than in the case of weights.

Absolute gains in the well-to-do and poor socio-economic status groups were 25.9 and 26.9 cm respectively compared to the 29.7 and 29.9 cm seen in the well-to-do Delhi children and the NCHS growth standards. Surprisingly, children in the residential schools gained only 26.9 cm – mainly because, at age five, these children were already taller than the NCHS standards.

Fig. 7. Increments in Heights and Weights of Girls and Boys between Ages 6 to 14 Years in Various Socio-economic Groups



Growth Of Girls During Adolescence

Growth during the adolescent period is an important determinant of adult body size. There are very few longitudinal studies which have looked into the growth pattern and the velocities of height and weight gains of Indian

girls during adolescence. Making use of available distance charts for heights and weights, it is possible to calculate the mean annual increments of these two measurements. These calculated figures from cross-sectional data may not be accurate estimates of velocities, but they do provide some information about the growth rates at different ages during adolescence.

Cross-sectional data of the ICMR growth study[64] show that between the ages of 10 and 18 years, the average Indian girl gains 23.3 cm in height and 18.8 kg in weight. Much of this is gained between the ages of 10 and 15 years (21.2 cm and 15.2 kg), and the increases thereafter are small, particularly with respect to height.

Socio-economic and rural-urban differences are seen with respect to these increments (Table 3). Girls belonging to the lowest socio-economic group (LSG) gain heights similar to those seen in girls belonging to the highest socio-economic group (HSG) between ages 10 and 15 years (20.6 cm vs. 20.9 cm), but thereafter, girls in LSG gain more than what girls in the HSG do (2.6 cm vs. 1.3 cm).

The pattern of weight gain is slightly different. Girls from the LSG gain considerably less than do girls from the HSG (14.3 vs. 16.7 kg) during the 10th and 15th years, but during the next three years they gain a little more (3.4 kg vs. 2.8 kg) as is the case with height increments.

Rural and urban girls gain similar amount of height both between 10 and 15 years and 15 and 18 years. Weight gains, however, are larger in the urban girls than in the rural (19.0 kg vs. 17.1 kg) during the 10- to 18-year period. Between the 15th and 18th years, weight gain is more among rural girls (4.2 kg vs. 3.0 kg).

A more recent study[57] on the growth pattern of adolescent school going girls belonging to the middle and lower middle income groups, in Chitoor, Andhra Pradesh, has shown that rural girls gain more height and weight than do their urban counterparts, the differences being over 4.5 cm and 1.4 kg. This observation is different from that made in the ICMR cross-sectional study. A likely explanation is that while the girls studied at Chitoor belonged to a relatively homeogenous socio-economic groups, girls in the ICMR study belonged to a heterogenous group comprising several socio-economic classes.

In a semilongitudinal study[48] of adolescent girls coming from well-to-do families in Varanasi, Uttar Pradesh, gains in heights and weights have been found to be somewhat higher than those reported for girls belonging to the HSG of the ICMR study (2.5 kg and 1.0 kg more). When compared to the NCHS standards, the increments seen in all the groups, including those belonging to the well-to-do in Varanasi, are lower for both height and weight. Increments in weight range from 67 to 77 percent of NCHS standards, while increments in height range from 90 to 95 percent. Mean heights and weights of girls at the age of 18 years in all groups are therefore lower than those of NCHS standards.

A somewhat surprising observation is related to the growth of Indian girls who belong to the affluent category in whom there are no constraints on growth[67]. These girls during their preschool ages and during their early school age, up to 10 years, have growth patterns almost identical with NCHS standards. In such girls, increments in height and weight between ages 10 and 18 years is not only much lower than NCHS standards, but also lower than those of even the lowest socio-economic group (LSG) of the ICMR study. This is particularly marked in the case of height gain. It appears to be due to a sharp reduction in growth rate at age 13 years and a persistent low velocity thereafter (Figures 8 and 9). That this may be real and not an observational error is supported by the finding that the same phenomenon is seen among well-to-do girls studied in Varanasi.

In a unique study[59] wherein the growth of rural girls in Hyderabad, Andhra Pradesh have been followed up over a period of over 20 years, from the age of five to adulthood, it has been found that the increments in height between the ages of five and 18 years, were inversely related to the degree of deficit in height at age five (Table 4). Those who had severe malnutrition and therefore were most stunted, showed the largest increments which exceeded NCHS standards. Normal and mildly malnourished girls had increments less than that of NCHS standards. This, however, was not true of weights. The gains were similar, irrespective of their weight status at age five.

These findings suggest that childhood and pre-adolescent malnutrition, even when severe, does not compromise linear growth during the adolescent period. If anything, the malnourished girls seem to grow better during this phase, which helps them to narrow the gap in heights present during the pre-adolescent period. The differences in velocity curves seen between the LSG and HSG in the ICMR study suggest that the LSG has a higher rate of gain in height between ages 14 and 17 years, which helps them to narrow down, to some extent, the initial height differences (Figure 10). This higher rate is not enough for a complete catch-up and as a result their adult heights and weights

Fig. 8. Annual Increments in Height and Weight of Indian Girls During Adolescence

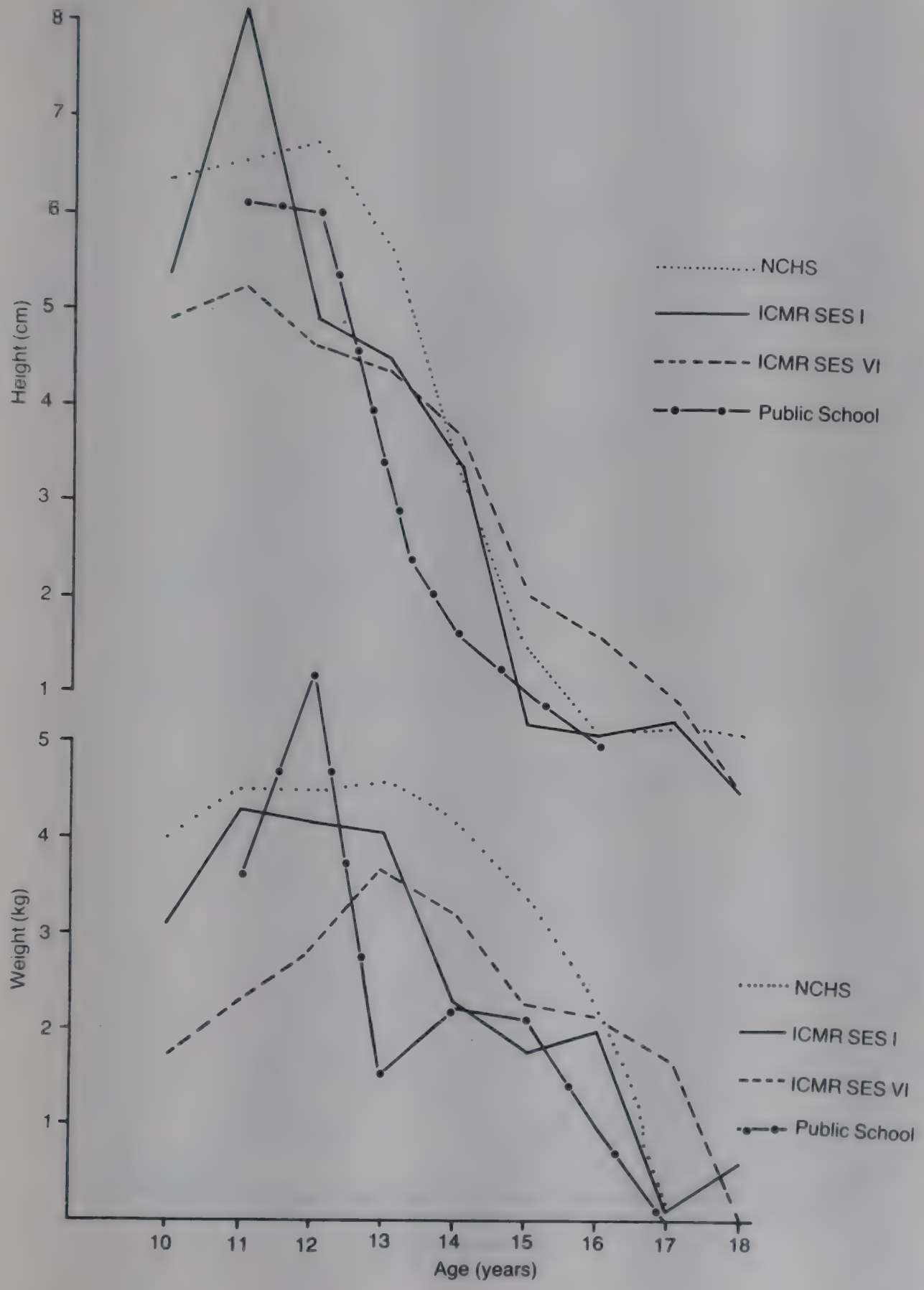


Fig. 9. Annual Increments in Height and Weight of Indian Girls During Adolescence

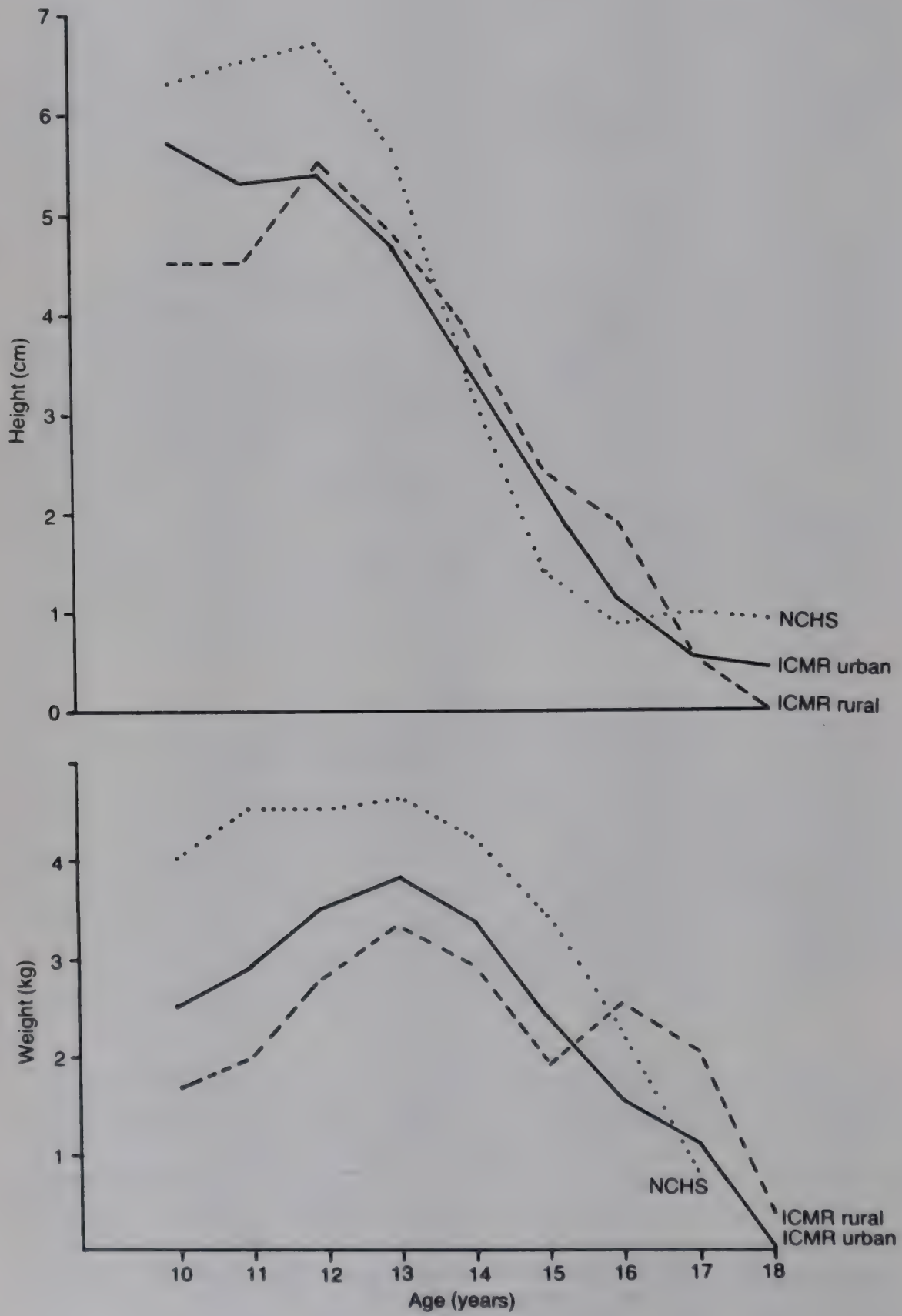
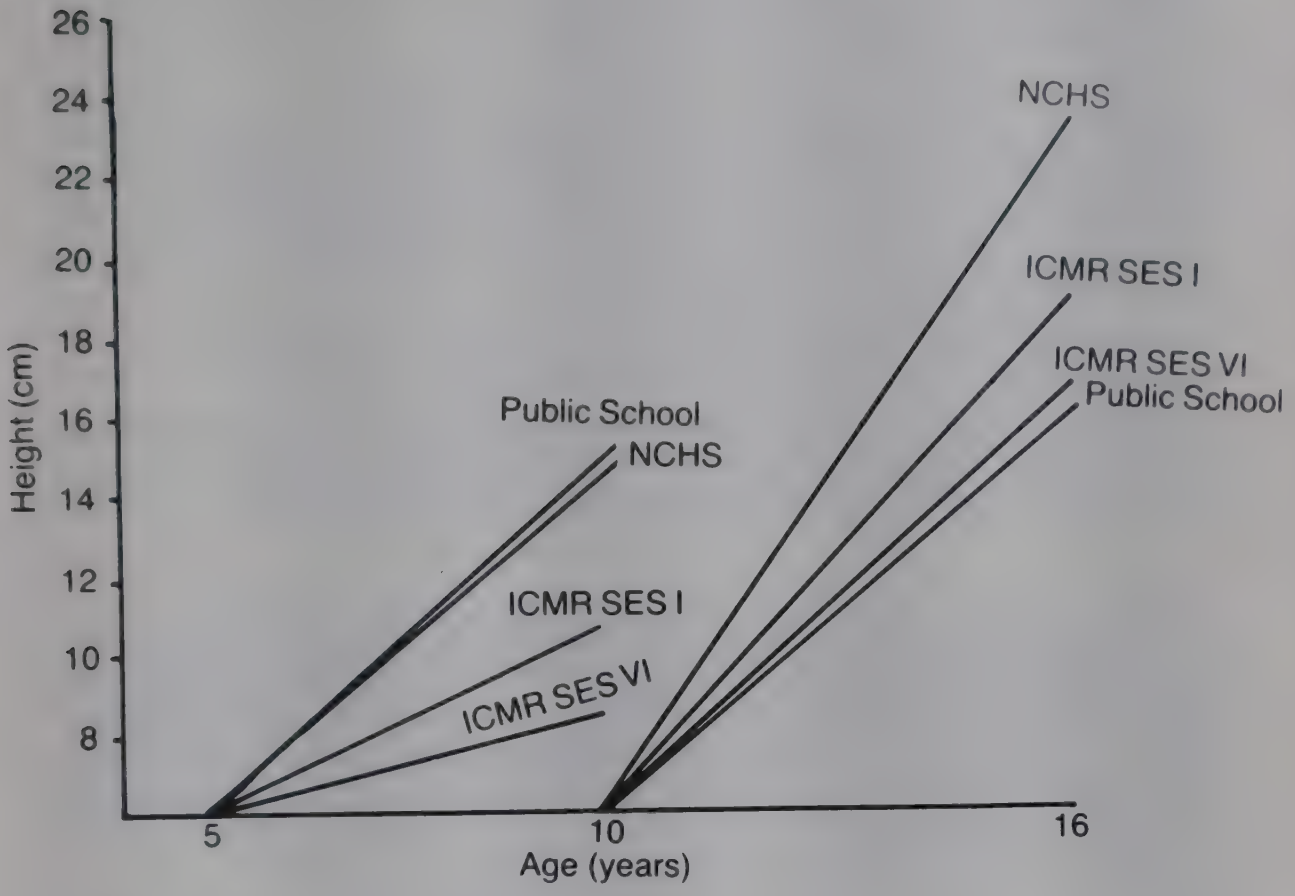
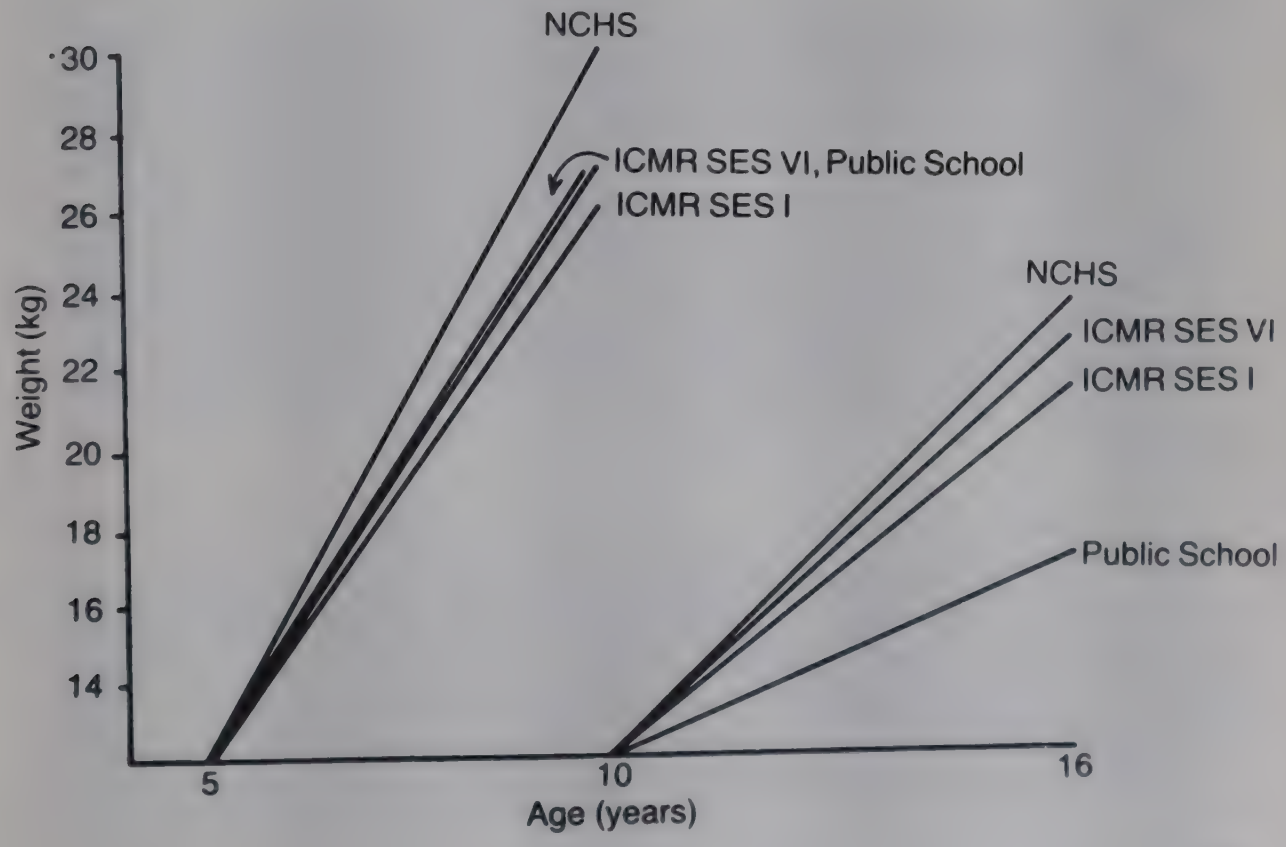


Fig. 10 Increments in Weights and Heights of Indian Girls During Adolescence





are lower than those of the HSG. The data obtained in the long term follow-up study of girls in Hyderabad, Andhra Pradesh, strongly suggest that the short stature of the adult rural woman in India belonging to the low socio-economic group is almost entirely a legacy of her childhood growth retardation due to environmental factors.

The short stature of the well-to-do Indian woman as compared to the NCHS standards is primarily due to a lower growth rate during adolescence – particularly after the age of 13 years. The reason for the lower rate is not clear. Since it cannot be ascribed to inadequate nutrition and health care, it may be speculated that it has a genetic basis.

Menarche: The onset of menstruation is a visible event in a sequence of changes which occur during adolescence and being a definitive timed phenomenon is often used as a valid indicator of sexual development.

Studies related to age at menarche of Indian girls date back to over a 100 years, but the most comprehensive one is that reported by the ICMR in 1972[64]. Marked individual variations in age at menarche have been noted – from a low nine years to a high 20 years. On an average, the Indian girl attains menarche between her 13th and 14th years, depending upon whether she lives in the urban or rural area.

There are significant differences in the age at menarche of urban girls in different parts of the country (Table 5). It is 11.38 years in Orissa and 14 years in Rajasthan, with Delhi, Andhra Pradesh, Madhya Pradesh, Madras, Jammu and Kashmir having values in between the two extremes, in this order. In most of these states, the mean age at which menarche occurred in the rural population was higher than that in the corresponding urban population, with the exception of Andhra Pradesh and Uttar Pradesh. Several recent studies have confirmed both the urban-rural differentials and the regional variations. Both in Madras and in Kerala rural girls attain menarche more than a year later than do urban girls[23] (14.60 and 12.76 in Madras; 14.42 and 13.25 in Kerala).

One of the most consistent findings about age at menarche is its inverse relationship with socio-economic status. In the poorest socio-economic group of India as a whole, mean age at menarche has been reported to be 14.56 years, which is 1.3 years more than that for the highest socio-economic group[64] (Table 6). Classified according to income alone, this difference remains – mean values being 14.3 years and 13.1 years (Table 7) for the

poor and well-to-do respectively. These trends have been confirmed in a number of independent investigations done in different parts of South India[5,55,62]. Among the Tamil and Telugu speaking populations, a one-year age difference has been seen between the poor and the rich. Two exceptions to this finding, both of which show only a marginal difference are those of Indirabai and Vijayalakshmi[3], who found a difference of less than 0.25 years between the best and worst income groups, and of the National Institute of Nutrition, Hyderabad[38], which found a mere 0.35 year difference between urban slum girls and girls from the upper income groups.

Studies which have related dietary habits with age at menarche are few. Ghosh *et al.*[15] in a retrospective study found that girls habitually eating non-vegetarian diets had attained menarche at the mean age of 13 years, those who were vegetarians by habit attained it only at 13.7 years. In contrast, Logambal *et al.* found no such differences[22].

The reasons for the age differences at menarche seen among the various socio-economic groups are not fully understood. Among other things, it has also been speculated that earlier and more intense exposure to social and sexual stimulation, through audiovisual experiences may have hastened the maturation process. From data available in the country at the macro-level, regional differences in age at menarche do not seem to be related to differences in nutritional status, as judged by weight and height measurements. Within a state, however, urban-rural differences can perhaps be partly explained on the differences in body size, since mean height and weight of urban girls are higher than those of corresponding rural girls. It may be significant that the mean body weights of Indian rural girls at the age of 14 years – which is the mean age at menarche — is 33.5 kg, a value essentially similar to the 34.3 kg of urban girls at the age of 13 years – which is their mean age at menarche[58]. At age 13, the average rural Indian girl is 3 kg lighter than her urban counterpart. In fact, between the ages of 12 and 16 years, which is the age range over which an overwhelming majority of girls attain menarche, the difference in body weights of urban and rural girls is of the order of 3 to 4 kg at each age interval.

That nutritional status influences the age at which menstruation begins is fairly certain. The observation that among South Indian girls, those who had attained menarche were significantly heavier and taller than those who had not, irrespective of the age at menarche, supports this contention[50]. This is further substantiated by the unique study of Satyanarayana *et al.* among Hyderabad rural girls[58]. In a prospective study which involved over 700 rural girls aged 12 to 16 years whose growth and nutritional status were being monitored from age five, it was observed that girls who were very short – a valid indicator of chronic, severe malnutrition, attained menarche only at a mean

age of 15.2 years as compared to 13.7 years among girls who had heights in the normal range. Those who had mean values for height in between also had mean values for age at menarche in between. At the age at menarche the very short girls were 5 cm shorter and 3 kg lighter than were the girls with normal heights. In both groups, weight for height, however, was similar.

It has been suggested that menarche is triggered by the attainment of a critical body weight and a critical body composition. For American girls, the critical weight is reported to be around 46 to 48 kg. Indian girls achieve menarche at much lower body weights. As mentioned earlier,at age 14, which is the mean age at menarche, mean body weight is no more than 36 kg and even in the well-to-do girls, the mean weight at menarche is around 39 kg. It may also be significant that in a prospective longitudinal study reported from Hyderabad, body weights of girls fell in the narrow range of 36 and 39 kg at the time of attaining menarche. This was irrespective of the chronological age, which showed a four-year spread – from 12 to 16 years. These observations strongly support the conclusion that body weight has a permissive role in the attainment of menarche and that delays in menarche may be reflections of altered nutritional status, if weight is accepted as a proxy for nutritional status. These findings also indicate that this critical weight varies from one country to another and that there may not be a single, universally applicable weight range.

Whether there has been a secular trend in our country with respect to age at menarche is not easy to determine, because samples covered have often been small, methods employed not uniform and regional variations quite pronounced. For the country as a whole, there is little evidence that age at menarche has come down, over the years (Table 8). This, however, cannot be taken to mean, that in specific groups, in some areas, secular changes have not occurred. Such a change has, in fact, very recently been reported among the poor Hyderabad rural area girls in whom the mean age at menarche has fallen to 12.7 years from 14.6 years in the early 1970s[41].

Heights And Weights Of Adult Indian Women

Data on anthropometric measurements of adult Indian women was, until recently, very scanty. It is during the last 15 years that some information has become available through studies done by the National Nutrition Monitoring Bureau[42]. These pertain mostly to rural women.

The mean heights and weights of women aged between 25 and 34 years,

living in rural areas of 10 states, are shown in Table 9 for the 10 states together. The rural Indian woman was 150.6 cm tall and weighed 42.4 kg. Regional variations were seen, but were not very striking. From a low 39.9 kg in West Bengal to a high 44.4 kg in Madhya Pradesh was the range. In the other eight states, values lay in the close range of 41.9 to 43.6 kg. Mean heights were lowest in West Bengal – 148.5 cm and highest in Gujarat – 152.9 cm. In the other eight states mean heights, like mean weights, were very close to each other, varying from 149.3 to 151.5 cm.

Weight for height appeared to be relatively constant in eight states – ranging from 27.9 to 28.9, while in West Bengal it was particularly low – 26.9 and in Madhya Pradesh, it was particularly high – 29.5. (These figures may, however, not be strictly correct, since they have been computed from mean heights and weights and not calculated from individual height and weight data.)

Mean heights and weights of urban slum dwellers – 150 cm and 42.2 kg, respectively seem to be essentially similar to those of rural women[43]. Urban women belonging to the low income group and women working in industrial establishments were heavier (44.8 kg) but not taller (150.7 cm) than were their rural counterparts (Table 10). Their weight for height, however, was similar to those of rural women.

Urban women belonging to the middle and high income groups were found to be taller and heavier than were the other urban groups[53]. There was a gradient between the middle and high income groups, showing the effect of socio-economic status. While the mean height and weight of women in the middle income groups were 151.8 cm and 49.2 kg respectively, corresponding values for the well-to-do groups were 154.9 cm and 52.2 kg. The weight for height in the two groups were 32.4 and 33.7.

It is significant that the mean heights and weights of rural women reported by the NNMB for 10 states is strikingly close to those reported by the ICMR earlier for the whole country[64] (Table 11). There are, however, differences in the measurements of the well-to-do groups, reported in the two studies. While the ICMR data show that the mean heights and weights of women belonging to the highest socio-economic group were 154.1 cm and 46.2 kg the NNMB data show that corresponding values are 154.9 cm and 52.2 kg[43]. Thus, while the heights are similar, weights are considerably higher in the NNMB study. This difference in weights may be due to one or both of two reasons. The number of observations in the NNMB study is much smaller than that in the ICMR study and, perhaps more importantly, the ICMR data refers to women aged 20 years – by which time linear growth would have been computed, but accretion of weight, perhaps had not.

The heights and weights of adult women of even the well-to-do groups in India are considerably lower than those considered as standard by the NCHS. By age 18 mean heights are 163.7 cm and mean weights 56.6 kg by NCHS standards.

Secular Trends In Growth Of Women

Over the last century, clear cut increments in heights and weights of population groups have been recorded in most developed countries and some developing countries of the world. This secular trend has been attributed in a large measure to improved nutrient intake and better medical and health care. There have been very few studies in India which have tried to determine whether such secular trends in growth are discernible though in very recent years, there have been a few attempts to examine this aspect. But data on anthropometric measurements available from various studies make it possible to examine this aspect of growth.

One early study designed to look for secular trends is that reported by Shantha Madhavan[24] *et al.* who found that heights and weights of adult men employed in a Railway Workshop in Hyderabad revealed a secular trend. In this study, women were not included. In a recent study carried out on 512 pairs of mothers and daughters, apparently healthy and belonging to the poor income groups in Hyderabad, Veena Shatrugna and Visveswara Rao[61] found the mean heights of daughters (150.4 cm) were in no way different from that of their mothers (150.1 cm). This was true of mean weights as well (44.7 and 45.7 kg). A comparison of mean heights and weights of women in rural areas of Hyderabad, belonging to two age groups separated by a span of 20 years (one Indian generation) showed that they were practically identical. Women aged between 19 and 28 years were 149.4 cm tall and weighed 41.8 kg, while women aged between 39 and 48 years were 149.2 cm tall and weighed 41.4 kg[53]. The same was true of women belonging to the urban lower middle income group (150.6 and 150.4 cm; 43.1 and 43.9 kg respectively for the younger and older women). Among women of the upper middle income group, however, mean height of the younger age group tended to be higher (151.5 cm) than that of the older age group (150.2 cm), though not statistically different. Body weights were distinctly higher in the older age group (52.0 kg vs. 47.2 kg). Whether the lower body weights in the younger age group is a reflection of an expresion of a deliberate attempt to keep it down, or is an age related physiological phenomenon, needs to be examined. These data may be interpreted as showing that among the poor and the lower middle income groups there are no secular trends in height. This has been confirmed by another study in 328 pairs of urban slum and 170 pairs of rural mothers and daughters.[40,41] The relatively large body of data collected and reported by the National Nutrition Monitoring Bureau[42] for the 10 states, for the period 1974-1979 tends to support this conclusion.

The mean heights and weights of rural women in the two age groups 25-29 and 45-49, representing a one generation gap, are presented in Tables 12 and 13. In the five states of Kerala, Tamil Nadu, Karnataka, Maharashtra and West Bengal, women in the younger age group tended to be taller by over 1.0 cm (range: 1.1 to 1.6 cm) while in four others – Uttar Pradesh, Andhra Pradesh, Madhya Pradesh and Gujarat — the younger women were taller by less than 1.0 cm (range: 0.3 to 0.9 cm). In the state of Orissa, the younger women were 0.5 cm shorter. Since information on the scatter of individual values is not available, it is difficult to say whether these differences are significant. The situation in men was essentially similar. In three states, the younger men were taller by more than 1.0 cm, in five others they were taller by less than a cm and in the remaining two, there were no differences.

The limitations of these comparisons must be pointed out. The two sets of women between whom comparisons have been, made may not have been in most instances, mothers and daughters and, in fact, may not even have come from the same household. The NNMB data is a pooled one covering subjects from different parts of the state and examined over a five-year period. Also, the ages as recorded may not have always been correct. The validity of any conclusions regarding the absence of secular trends in height from these sets of figures may therefore be questioned. A reanalysis of the NNMB data collected in a single year, parent-offspring-wise, may be expected to provide more reliable estimates of secular trends, if any.

Data regarding the body weights of the two age groups are presented in Table 14. Only in Kerala, West Bengal and Uttar Pradesh were the younger age groups of women heavier by more than a kg. In five states, the younger women were either lighter or had weights similar to that of the older group.

Utilising data for 60 population groups, in which heights were obtained from subjects belonging to the same population, at different points of time and using the criteria (a) the time gap between the two sets of data be at least 25 years, (b) sample size be a minimum of 30 and (c) both samples be drawn from the same Mendelian population, from the same geographical region or state, Ganguly[13] has reported that there is a clear negative secular trend for Indian subjects. Of the 60 population groups, 43 had become shorter in the course of one or two generations. The socio-economic status of these 60 population groups has not been defined and it would be important to see whether the 14 groups, in which there was no negative trend, in fact belonged to the economically well-off sections.

Data on the urban population collected by the NNMB[43] also show that women in the age group 25-29, who come from the low and low middle

income groups, as also women working in industrial establishments are between 0.5 and 1.7 cm taller than women in the age group 45-49, while among slum dwellers, the younger generation was slightly shorter. In sharp contrast, the younger women belonging to the well-to-do groups were over 4.0 cm taller than the older generation. This observation may be considered to be complementary to that reported by Kapoor *et al.*[20] that among the urban Delhi middle income group adult daughters were clearly taller than their mothers, by 2.7 cm – an observation that suggests that while a secular trend in height is perhaps present among the better income groups, this is not evident among the poorer sections. As far as the NNMB urban data is concerned, the limitations pointed out for the rural groups apply to the urban too, in addition to the much smaller sample size.

Body weight changes with age: It has long been recognised that in adult life, with advancing years, body weights tend to rise. This age-related change has been ascribed to a combination of reduced energy requirements, increased sedentary nature of life styles and altered hormonal profile. Data available in our country clearly show that this age-related weight change is economic-status dependent (Table 14). The NNMB data[42] show that in all the 10 states mean body weights of women in the 50-55-year age group was only marginally different from that of young women in the age group 20-25 years, without exception.

In the urban population[43], the same trend is evident among the slum dwellers and the industrial workers. In the other three income groups, the lower, middle and upper income group, however, body weights showed an increase with age. In the high, middle and low income groups, weight differences were 8.4, 5.4 and 1.4 kg respectively. In an independent study[55], it has been found that the Hyderabad rural poor and urban lower middle income women show no gain in body weights with age, while the upper middle income women show an increase of almost 5 kg. An important reason for this income-related difference in the age-dependent weight gain may be the necessity for women, in all but the high and upper middle income groups, to engage themselves in physical activity for economic reasons.

Table 1

Birth Weights of Infants in India

Place	Year	Type of population	Boys	Girls	N	Reference
Bombay	1987	Hospital: Urban poor	2750		411	45
Calcutta	1987	Hospital: Urban Poor	2760		346	45
Calcutta	1952		2700	2640		4
New Delhi	1962-1973	Poor	2850	2760	2812	11
	1968	Middle class	2980	2760	101	14
	1972	Urban	2870	2785	5866	16
	1971	Well-to-do	2988	2895	5866	46
	1982	Well-to-do	3400	3100		11
Hyderabad	1962	High income	3182		1753	66
	1979	Low income	2810		2777	
		Hospital poor	2700		4161	27
	1980	Rural	2710		3321	30
		Urban	2700		562	
	1982	Rural	2680		1796	31
	1983	Slum	2840	2770	1310	35
	1984	Rural	2650		1849	
	1985		2690			
	1980	Rural:Normal	2620		30	28
		Mild Malnut.	2550		66	
		Moderate Malnut.	2570		49	
		Severe Malnut.	2410		37	
Lucknow	1973	Well-to-do	3300	3260	100	9
Madras	1949	Well-to-do	3100			17
		Poor	2700			
Madras	1962	General ward	2736			1
		Special ward	2948		6347	
	1987	Hospital poor	2700		254	45
Ootacamund	1960	Hospital:				
		Mixed	2960	2960	1338	56
		Poor	2760	2700		
		Well-to-do	3150	3000		
Vellore	1982	Rural	2754	2685	2345	54
		Urban	2863	2820	1875	

N: sample size

Table 2

Mean Weights of Indian Girls Aged One to Five Years: kg

Age	ICMR Socio-economic Status VI	ICMR[64] Socio-economic Status I	High income	Delhi well-to-do Ghosh[16]	Delhi well-to-do Banik[12]	Hyderabad*[52] Well-to-do	Hyderabad*[52] NCHS
1	7.5	8.8	8.8	8.8	9.6	8.8	9.5
2	9.2	10.3	10.3	10.9	11.9	10.7	11.8
3	10.9	12.4	12.3	13.0	13.7	12.6	14.1
4	12.4	14.1	14.2	14.5	16.3	14.5	16.0
5	14.0	16.1	16.0	16.3	18.1	16.5	17.7
Gain in weight: Kg from 1-5 years	*6.6*	*7.3*	*7.2*	*7.5*	*8.5*	*7.8*	*8.2*

** Extrapolated values*

Mean Heights of Indian girls: aged one to five years: cm

1	71.8	76.3	75.6	72.5	74.0	73.0	74.3
2	79.1	82.2	82.8	82.8	86.5	82.5	84.5
3	86.1	91.3	91.3	92.2	95.7	92.5	93.9
4	93.0	99.0	98.9	98.9	101.8	100.0	101.6
5	99.8	106.6	106.6	105.6	108.3	107.0	108.4
Gain in Height: cm from 1-5 yrs	*28.9*	*30.3*	*31.0*	*33.1*	*34.3*	*34.0*	*34.1*

Table 3

Gain in Weight and Height of Indian Girls During Adolescence

	Weight gain: kg between		Height gain: cm between	
	10-15 years	10-18 years	10-15 years	10-18 years
ICMR Study[64]				
Pooled	15.2	18.8	21.2	23.3
Highest Socio-economic group	16.7	19.5	20.6	21.9
Lowest Socio-economic group	14.3	17.7	20.9	23.5
Rural	12.9	17.1	21.0	23.4
Urban	16.0	19.0	21.1	23.1
Varanasi[48]				
Well-to-do	–	17.5	–	20.7
NCHS	23.5	25.4	21.2	24.1

Table 4

Nutritional Status at Age Five and Subsequent Increments in Height and Weight*

Nutritional status at age 5 years	Height (cm) at age 5	Height (cm) at age 18	Increments in height (cm) between 5 and 18 years
Normal	104.3	155.9	51.8
Growth Retardation			
Mild	100.0	152.7	54.0
Moderate	95.7	151.1	55.3
Severe	90.1	148.2	58.2
NCHS	108.4	163.7	55.3

* *Increments in weight ranged from 28.7 to 29.1 kg in the four groups. Ref. 59*

Table 5

Mean Age at Menarche of Indian Girls in Different Regions

State	Urban	Rural
Orissa	11.38	–
Delhi	12.34	–
Andhra Pradesh	12.81	12.27
Madhya Pradesh	12.96	–
Uttar Pradesh	13.35	12.94
Madras	13.42	14.29
Jammu and Kashmir	13.59	14.80
Punjab	13.67	14.21
Maharashtra	13.70	14.63
Kerala	13.77	14.64
Rajasthan	14.00	–

Ref. 64

Table 6

Influence of Socio-economic Status on Age at Menarche

Socio-economic status	Mean age at menarche (years)
I	13.21
II	13.27
III	13.34
IV	13.60
V	14.03
VI	14.56

Ref. 64

Table 7

Influence of Per Capita Income on Age at Menarche

Per capita income rupees/month	Mean age at menarche (years)
≤ 50	14.02
51-100	14.59
101-200	14.12
201-400	13.66
401-600	13.32
601-900	13.31
> 900	13.01

Ref. 64

Table 8

Age at Menarche of Indian Girls*

Region	Year of Report	Mean age at menarche: years	Ref.
Calcutta	1851	12.50	
Deccan	1851	13.50	
Bombay	1945	13.00	
	1957	12.80	
Central India	1955	14.65	
Madras	1955	13.50	
Maharashtra	1950	14.06	
Bengal	1951	13.20	
Gujarat	1958	14.80	60
Assam	1961	13.20	
Bengal	1961	13.60	
Madras Rural	1965	14.16	23
Urban	1965	12.76	
Kerala Rural	1965	14.42	23
Urban	1965	13.24	
Madras	1969	14.84	
Poona	1973	13.20	
Uttar Pradesh	1974	12.80	
Hyderabad Urban Slum	1985	12.40	60
Hyderabad Rural	1987	12.7	41

** From Ghosh, Kochar and Khanna[15], except those which have their own reference numbers.*

Table 9

Mean Heights and Weights of Rural Adult Women in India (ages 25-44 years, 10 states)*

State	N	Height (cm)	Weight (kg)	Weight for height^2 (BMI)** (kg/m^2)
Kerala	1290	149.3	42.3	18.98
Tamil Nadu	1385	150.7	43.5	28.90
Karnataka	1976	151.5	42.6	18.56
Andhra Pradesh	1645	150.8	42.7	18.80
Maharashtra	1560	150.1	41.5	18.42
Gujarat	1791	152.9	43.6	18.66
Madhya Pradesh	873	150.7	44.4	19.55
Orissa	474	148.6	42.0	19.02
West Bengal	1344	148.5	39.9	18.10
Uttar Pradesh	1288	150.0	41.9	18.62

* *Calculated data Ref. 42*

** *Body Mass Index*

Table 10

Mean Heights and Weights of Indian Women

	N	Height (cm)	Weight (kg)	BMI (kg/m^2)
NNMB				
Rural	13626	150.6	42.4	18.69
Urban				
High income	129	154.9	52.2	21.75
Middle income	592	151.8	49.2	21.35
Low income	538	150.4	44.8	19.81
Industrial workers	661	150.7	44.8	19.73
Slum dwellers	649	150.0	42.2	18.76
Indian Council of Medical Research				
Rural		150.7	42.0	18.49
Urban		152.1	44.3	19.16

Table 11

Comparison of Mean Heights and Weights of Adult Indian Women: ICMR and NNMB Data

	Height (cm)	Weight (kg)	BMI (kg/m^2)
Rural			
NNMB	150.6	42.4	18.69
ICMR	150.7	42.0	18.50
Urban well-to-do			
NNMB	154.9	52.2	21.76
ICMR	154.1	46.2	19.45

Table 12

Secular Trends: Mean Body Weights of Adult Men and Women, NNMB: 1974-1979

	Women		Men	
Age group	25-29	45-49	25-29	45-49
State				
Kerala	42.7	41.3	48.8	46.8
Tamil Nadu	43.0	44.1	49.8	51.4
Karnataka	42.8	41.6	50.0	49.5
Andhra Pradesh	42.9	43.6	49.6	49.6
Maharashtra	41.8	41.7	49.4	48.9
Gujarat	43.2	43.3	49.4	48.3
Madhya Pradesh	44.4	44.2	50.9	51.6
Orissa	41.9	42.8	50.1	48.8
West Bengal	40.8	39.1	47.9	46.2
Uttar Pradesh	42.9	41.8	50.4	50.7

Table 13

Secular Trends: Mean Heights of Adult Men and Women, NNMB: 1974-1979

	Women		Men	
Age group	25-29	45-49	25-29	45-49
State				
Kerala	149.8	148.1	162.1	160.0
Tamil Nadu	151.0	149.8	163.0	163.4
Karnataka	151.7	150.3	164.7	163.4
Andhra Pradesh	151.3	150.7	163.4	162.5
Maharashtra	150.6	149.4	163.2	162.4
Gujarat	151.5	151.2	164.1	163.8
Madhya Pradesh	150.8	150.2	163.6	163.7
Orissa	149.1	149.6	162.3	160.5
West Bengal	149.1	147.9	161.3	160.5
Uttar Pradesh	149.3	148.4	163.5	163.6

Table 14

Age-Related Weight Changes in Women

	Age group	
State	20-25	50-55
Rural		
Kerala	42.7	41.2
Tamil Nadu	43.0	41.7
Karnataka	42.2	41.7
Andhra Pradesh	42.5	43.1
Maharashtra	41.9	40.0
Gujarat	43.9	43.9
Madhya Pradesh	44.2	43.3
Orissa	43.6	42.8
West Bengal	41.0	36.3
Uttar Pradesh	42.6	40.8
Urban		
High income	46.8	55.2
Middle income	44.6	51.0
Low income	42.8	44.2
Industrial	43.2	43.3
Slum	41.7	42.1

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Nutrition In Pregnancy

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Pregnant and lactating women have been widely recognised as a vulnerable group from the health and nutritional point of view. Considerable attention has been paid to their dietary intake and nutritional status. It was universally accepted that the lactating woman needed more food to produce milk for her offspring. However, two diametrically opposite views were prevalent regarding nutritional needs during pregnancy. One view was that pregnant women should eat more to provide for the needs of the growing foetus. The other view was that over-feeding would result in babies being too large and lead to problems in labour. In the early decades of the present century, nutrition scientists subscribed to the former view, and obstetricians to the latter view.

Basic research studies on nutritional requirements during pregnancy undertaken in developed countries during the '50s and '60s, strengthened the nutrition scientists' view that pregnant women need more food. The epidemiological data on adverse consequences associated with undernutrition during pregnancy, obtained mainly from developing countries, and the ready availability of methods for safe delivery of large babies, led to the obstetricians finally joining the nutrition scientists in advocating extra food intake during pregnancy.

Just when it appeared that a consensus had been reached, some new problems cropped up. Epidemiological data from developed countries indicated that in well-nourished women additional dietary intake during pregnancy may not be needed to ensure favourable outcome of pregnancy. Other studies suggested that increased dietary intake during pregnancy and lactation might, in fact, lead to obesity in these women.

Data from developing countries highlighted the deleterious effects of specific nutritional deficiencies, strenuous physical work, adolescent pregnancies, poor birth spacing, dual stress of pregnancy and lactation on nutritional status of pregnant women and the outcome of their pregnancy. These studies also showed that unless coupled with adequate health care, increasing dietary intake alone might not result in improved obstetric performance. Data from some of the recent studies on nutritional status during pregnancy and the influence of maternal nutrition on course and outcome of pregnancy will be briefly reviewed in the following pages.

Maternal Nutrition And Outcome Of Pregnancy

Nutritional requirements during pregnancy: Studies on nutritional requirements during pregnancy suggested that pregnant women need an extra allowance of about 300 kilo calories per day during the second and third trimester of pregnancy[13]. This has been computed on the basis of the fact that there is an increase in body weight during pregnancy and the extra work needed to carry on normal activities might cost as much as 20 percent more energy. Some of the earlier studies also suggested that the basal metabolic rate might be increased by 10 to 15 percent during pregnancy[12]. However, studies undertaken by Durnin had shown that basic metabolic rate is reduced during the second and third trimester of pregnancy[27]. Studies on work activity in pregnant women suggest that during pregnancy a majority of women from developed countries reduce physical activity. The saving in nutrients from reduction in BMR and reduced work activity during pregnancy appears to be sufficient to meet the increased requirements essential for the needs of the growing foetus and physiological changes during pregnancy[27]. However, this situation might not be applicable to the developing countries where low dietary intake and poor pre-pregnant nutritional status are very common.

Taking these factors into consideration, the Indian Council of Medical Research has recommended that the dietary allowances for pregnant women should included an additional 300 Kcal of energy and 10 to 15 grams of protein daily, over and above the recommended intake for the age and weight matched persons during the non-pregnant period[14]. These increased needs can be readily satisfied, if pregnant women consume one-sixth more the amount of food that they habitually eat.

Dietary intake and nutritional status of pregnant women: Studies conducted in U.S.A. and U.K. among well nourished women who did not have any economic constraints coming in the way of dietary intake and who were eating to appetite have shown that there was no increase in dietary intake during pregnancy in this group. The habitual dietary intake varied from 1500-

2200 kilo calories per day. These women gained on average about 10 to 12 kilograms during pregnancy and delivered infants whose mean birth weight was about 3.3 kilograms. Several studies have now documented that in well-nourished population groups, good weight gain during pregnancy and optimal obstetric outcome might be achieved over a wide range of habitual dietary intake with or without any increment in dietary intake during pregnancy[39,63].

These studies from developed countries take into account diets consumed over a short period of few months in a habitually well-nourished population among whom physical work during pregnancy is minimal. It is, however, possible that chronic maternal undernutrition and overwork weight pose a serious threat to the welfare of the mother and the foetus in utero.

Several studies have been undertaken in developing countries like India, to define the effect of low dietary intake and maternal undernutrition on pregnancy outcome[25,28-31,35,44,61,62]. Studies from all the developing countries indicate that there is a socio-economic gradient in dietary intake, maternal nutritional status and outcome of pregnancy. Studies from India have shown that women from the upper income group consumed 2000 to 2500 Kcal per day during pregnancy. In this group pregnant women do not perform hard physical labour during pregnancy and work activity shows a reduction during pregnancy. The pre-pregnancy weight in this population group ranges between 45-55 kilograms and the mean pregnancy weight gain is about 11 kilograms. The mean birth weight of infants is 3.1 kg (Table 1)[44]. These findings are similar to those reported from women in developed countries.

Dietary intake of low income group, urban women in India ranges from 1200-1600 kilo calories per day. There is no increase in dietary intake during pregnancy[5,21,38,42,43,60,64]. However, pregnant women continue to look after the household and other activities and remain moderately active throughout pregnancy. These women weigh an average 43 kilos prior to pregnancy and gain six kg during pregnancy (Table 2)[38]. The mean birth weight of infants is 2.7 kg. There is no obvious deterioration in maternal nutritional status during pregnancy or following repeated pregnancies provided the interbirth interval is longer than 24 months.

In rural India, dietary intakes of women from the low income group are essentially similar to the dietary intakes of urban women reported earlier[17,36,37,59] However, rural women have to spend more energy in daily household chores. For instance, they have to fetch drinking water from

sources which may be one to two kilometres from home, gather and bring firewood from the forest miles away. Most rural women from the low income group also help their husbands in agricultural activities, especially during weeding, replanting and harvesting seasons. It is therefore not surprising to find that these women weigh about 1 to 2 kilos less than their urban counterparts and their fatfold thickness is only half that of the urban women. These women gain about 5 kg during pregnancy[2,8] (Table 3) and the mean birth weight of their infants is 2.7 kg[8]. In rural communities also there is no significant deterioration in maternal nutritional status during pregnancy and after repeated pregnancies, provided the interbirth interval is longer than 24 months. Data from several other developing countries indicate a similar trend.

There have been very few indepth investigations on dietary intake, energy balance and body composition in undernourished population groups subsisting on habitual diets well below the recommended dietary intake. Durnin had undertaken such a study in women living in two contrasting environments in New Guinea. The coastal group subsisted on 1400 kilo calories per day while the highlanders ate about 2000 kilo calories per day. There was no increment in dietary intake during pregnancy in either of the communities; there was some reduction in physical activity during pregnancy in both groups. The pre-pregnancy weight gain and birth weight were similar in both communities. There was no loss in body weight and no changes in body composition with repeated pregnancies in either of the communities, though by conventional computation of energy balance studies, the coastal community was showing marked energy deficit[26]. These data suggest that similar weight gain during pregnancy and outcome of pregnancy might be achieved in communities where habitual dietary intake ranges from 1200 to 2000 kilo calories per day, pre-pregnancy weight ranging from 40 to 50 kilograms and varying grades of habitual physical activity. Obviously, there are some exquisitely sensitive but ill understood adaptive changes which bring about energy balance and ensure maintenance of maternal nutrition and satisfactory outcome of pregnancy in spite of widely varying habitual dietary intakes well below the RDA. It has been suggested that efficiency of energy utilisation increases under such circumstances. These speculations are difficult to verify because, at the moment,tools for evaluation of efficiency of energy utilisation, even indirectly by measurement of various related parametres, do not exist.

Studies from Gambia indicate that when food becomes available a reversal of these adaptive changes takes precedence over the improvement in maternal body weight[57]. These data suggest that the physiological cost of adaptive changes may be high, necessitating their prompt reversal as soon as food becomes available. What are these adaptive changes? How are they brought about? And at what cost? Are there limitations to these adaptive processes? We do not know the answer to any of these questions. It is imperative that energetic and earnest attempts be made to obtain the answers.

There is some evidence to suggest that a combination of reduction in dietary intake to below habitual levels and simultaneous increase in physical activity causes a "break down" of these adaptive processes and results in deterioration of maternal nutritional status and poor intrauterine growth of the foetus. Studies in rural communities in Gambia have shown that dietary intakes are lowest and physical activity is highest in the wet season. During these periods pregnancy weight gain is very poor, the mean birth weights are lower and prematurity rates are higher than those seen during other seasons. During the post-harvest season, food is available in abundance and work is less. Dietary intake improved and with this there is a marked increase in pregnancy weight gain, so that the earlier reduction in weight gain is more or less compensated [57].

Thus, in these traditional food growing agricultural communities, there are factors that mitigate the ill effects of the adverse seasonal circumstances. This mitigating effect might be completely lost in the cash crop-based plantation type agricultural and nonagricultural operation in which women are increasingly employed. For instance, in tea or rubber plantations, pay is linked to work and pay gives purchasing power. If women do not work or there is a reduction in physical activity, the wages go down and food cannot be bought. Continued heavy work throughout pregnancy coupled with low dietary intake may have an adverse effect on maternal nutrition and the course and outcome of pregnancy.

It is logical that the crucial factor that determines the maternal nutritional status and outcome of pregnancy might be neither the dietary intake nor the physical work done during pregnancy, but the energy deficit due to the gap between energy intake and energy expenditure. The calorie gap could be diminished either by attempting to reduce the energy expenditure or by increasing dietary intake. Measures to reduce energy expenditure might include simple measures like provision of potable water in the vicinity, provision of biogas plants to provide ready access to fuel for domestic use. Such measures require some economic inputs, but more important is the political and social will for successful continued implementation of such programmes, whose visible benefits are few.

Effect of food supplementation during pregnancy: Women form a major part of the national work force and for social and economic reasons cannot be discouraged from working outside the home. Since it would appear that among poorer segments of populations in developing countries, physical work during pregnancy could not be reduced without serious social, economic and domestic sequelae, attention has been focussed on investigating whether food supplements,given to pregnant women to reduce the energy gap, could mitigate some of the adverse obstetric consequences of undernutrition in these women.

Some of the earliest studies on the effect of food supplementation to undernourished women on course and outcome of pregnancy were undertaken in the National Institute of Nutrition, Hyderabad, India and INCAP, Gautemala[24,28,29,32,44]. Data from both these studies demonstrated that food supplements during pregnancy resulted in improvements in birth weight and reduction in prematurity rate. Studies from Gautemala showed that calories were the critical component of dietary supplement in relation to improvement in birth weight. Though dietary supplements throughout pregnancy were the most effective, food supplements even over shorter periods during any trimester, exerted some beneficial effect. More recent studies from India and Gambia have confirmed this[16,22,57].

Encouraged by such data, almost all developing countries have embarked on food supplementation programmes for pregnant and lactating women. Very few of these programnmes have been evaluated for the impact of food supplements on birth weight. Available limited data, however, suggest that the impact, if any, is very limited. One of the major problems in food supplementation programmes is that even when the logistics of reaching the food to women have been meticulously worked out and efficiently carried out, food sharing within the family of the recipient results in the 'target' women not getting the supplements in significant quantities. Obviously this might be an important factor responsible for the demonstrated lack of beneficial effect.

In the earlier studies from the National Institute of Nutrition, Hyderabad, in an effort to ensure consumption of food supplements by the pregnant women, all these women were admitted in the antenatal wards. Thus in addition to food supplements, two other factors that improve birth weight, namely, enforced rest and very good antenatal care, were operating. Results of some of the later studies have shown that antenatal care alone given during the second half of pregnancy had a similar impact on birth weight, prematurity rate and perinatal mortality rate[24]. Efforts to ensure consumption of food supplements by pregnant women, inevitably bring such women under closer supervision and consequent better health care. It is therefore difficult to design studies that will segregate the effect of food supplements from those of improved health care and reduction of energy expenditure.

Course and outcome of pregnancy in undernourished women: It has been computed that foetal wastages — abortion, intrauterine deaths and still births — occur in about 20 percent of conceptions in poorer segments of the population in developing countries. The mean birth weight of infants born to these women is 2.7 kg. Perinatal mortality in such communities varies between 50-70 per thousand live births[28-30,44,62]. These data have been interpreted as indi-

cative of adverse consequences of maternal undernutrition on course and outcome of pregnancy. However, when the data from these studies are further analysed it becomes obvious that women from these segments of population suffered from several pregnancy-associated problems such as anaemia and pregnancy induced hypertension. Very few of them seek or obtain adequate antenatal care. Thus it is obvious that part of the observed association between poor maternal nutrition and poor obstetric outcome might be attributable to the higher prevalence of maternal risk factors during pregnancy and poor antenatal care [44,46]. Combining adequate antenatal care with effective food supplementation programmes is likely to result in substantial improvement in outcome of pregnancy in undernourished communities.

Until such time when sufficient clear-cut data are available regarding the relative contribution of adequate food intake to meet energy needs of women and adequate health care services in ensuring favourable outcome of pregnancy, policy planners might be advised to take a pragmatic view and take advantage of existing circumstances. It is essential that mankind should achieve freedom from hunger. So all food supplementation programmes aimed at anyone in the poorer segments of the population is desirable because though food may not reach the 'target' person, it does go to feed the hungry. Provision of food, in addition, provides an acceptable entry point for health care workers and therefore indirectly might result in improved health care. Such an intergrated health and nutrition package might achieve the desired effect of improvement in health and nutritional status of the mother and the offspring among the poorer segments of the population in developing countries.

Anaemia In Pregnancy

It has long been recognised that anaemia is a major nutritional problem in pregnancy in poorer segments of the population in developing countries. Studies conducted in India indicate that maternal anaemia is associated with increased maternal morbidity and mortality. Association between maternal anaemia and low birth weight, prematurity and high perinatal mortality has been documented by many studies in India [1,40,46].

Prevalence of anaemia in pregnancy: Several large scale surveys on haemoglobin status of urban and rural pregnant women from low income groups have been undertaken during the last 10 years.

Studies in haemoglobin status during pregnancy indicate that anaemia

often antedates pregnancy. There is a slow and gradual fall in haemoglobin level during pregnancy. The lowest mean haemoglobin levels were seen between 24-32 weeks of pregnancy. In the third trimester there was a slow rise in mean haemoglobin level till term (Table 4). The trend and magnitude of fall in haemoglobin levels in urban and rural women from different income groups were similar, though there was a significant difference in the mean haemoglobin levels between different groups. These data suggest that changes in plasma and RBC volume may be major determinants of changes in haemoglobin levels during pregnancy, even in undernourished women from developing countries, among whom iron and folate deficiency are known to be widely prevalent[49].

All available data suggest that prevalence of anaemia in pregnancy (< 11g/dl) continues to be high especially among low income groups. The reported prevalence rates range from 40-50 percent in some urban areas, 50-70 percent in rural areas, to almost 90 percent in rural areas where hookworm infestation is endemic.

Consequences of anaemia in pregnancy: Studies to define the functional decompensation due to anaemia in pregnancy indicate that different types of decompensation occur with varying degrees of anaemia. Most of the studies indicate that fall in maternal haemoglobin below 11 g/dl is associated with a significant rise in perinatal mortality rate. There is usually two-to three-fold increase in perinatal mortality rate when maternal haemoglobin levels fall below 8 g/dl and eight-to 10-fold increase when maternal haemoglobin levels fall below 5 g/dl[47].

A significant fall in birth weight due to increase in prematurity rate and intrauterine growth retardation[47] has been reported to occur when maternal haemoglobin levels were below 8 g/dl (Table 5). Maternal immune depression[52] (Table 6) and increase in morbidity due to infections have been reported in women with haemoglobin levels below 8 g/dl. Maternal mortality rates show a steep rise if maternal haemoglobin levels fall below 5 g/dl.

Investigations have been undertaken to determine factors responsible for the adverse maternal and perinatal outcome seen in association with anaemia. These studies indicate that anaemia per se might be responsible for some of the observed adverse effects. However, prevalence of several maternal risk factors which are associated with low birth weight and increased perinatal mortality such as twins, antepartum haemorrhage and maternal undernutrition are higher among anaemic women. It is, therefore, possible that coexisting obstetric problems contribute, at least in part, to the adverse

obstetric outcome reported among anaemic women. Anaemic women should, therefore, be treated as a high risk obstetric group, requiring adequate obstetric care.

Immune depression due to anaemia and consequent increased morbidity due to infection, especially urinary tract infection, might be some of the factors responsible for low birth weight in anaemic women. Screening for, and effectively treating, infections in anaemic women might therefore result in improved foetal and maternal prognosis.

In the cereal and pulse based habitual diets consumed by Indian women, there is an almost linear correlation between calorie and iron intake[58]. Women with haemoglobin levels below 8 g/dl weigh less than their non-anaemic counterparts from similar income groups[47]. These data suggest that anaemia might be one manifestation of overall maternal dietary inadequacy and consequent undernutrition. It is possible that supplementary feeding programmes aimed at improvement of maternal dietary intake might result in some improvement in maternal haemoglobin status also.

Poverty, ignorance, non-availability and/or failure to utilise available medical facilities have been shown to be associated with maternal anaemia on the one hand and maternal and perinatal morbidity and mortality on the other, though the association is not causal. Health education to improve utilisation of available facilities and improvement in health care delivery system to cater to the needy, right at their door steps, might thus go a long way in reducing adverse obstetric outcome associated with maternal anaemia.

Management of anaemia in pregnancy: Investigations undertaken among Indian women from low income groups in the,50s showed that prevalence of anaemia was between 50 and 90 percent in the third trimester of pregnancy. Anaemia was found to be mainly due to iron and folate deficiency. Based on these findings the national anaemia prophylaxis programme of iron and folic acid distribution to pregnant women was initiated[11,34].The implementation and impact of this programme are currently being evaluated. However, data from hospital studies and the available meagre information from community based surveys on prevalence of anaemia in urban and rural population, suggest that prevalence of anaemia during pregnancy has remained essentially unaltered over the past three decades. Anaemia still remains the major nutritional problem associated with maternal and perinatal morbidity and mortality. These findings have been a source of concern for research workers, health planners and administrators.

It is possible that in an attempt to cover the entire vulnerable population of pregnant women, the available limited health manpower resources have been too thinly spread. This might have prevented effective functioning and hence the observed lack of impact in terms of reduction in prevalence of anaemia during pregnancy. It has been suggested that when dealing with problems of vast magnitude, like anaemia, with available limited resources, the risk-care approach might pay higher dividends in terms of reduction in perinatal morbidity and mortality. Women with haemoglobin less than 8 g/dl show functional decompensation and constitute a high risk group. The first task is therefore to ensure screening of all pregnant women to identify this high risk group. Available data suggest that it is not possible to identify these women clinically. Among the various methods available for haemoglobin estimation, the cyanmethaemoglobin method appears to be the most reliable, rapid and inexpensive for screening pregnant women for anaemia. The feasibility of using this method for haemoglobin estimation in large scale urban and rural community based studies have been demonstrated. Some of the studies for the National Institute of Nutrition suggest that a single haemoglobin estimation done around the 20th week of pregnancy might be sufficient to detect the high risk anaemic pregnant women. At the moment there are no screening programmes for detection of anaemic pregnant women in the urban and rural communities. It is essential to evolve such a programme so that anaemia in pregnancy could be detected and effectively treated.

Management of anaemia in pregnant women depends upon the haemoglobin level,period of pregnancy and presence of obstetric or other complications. Women with haemoglobin levels below 5 g/dl require immediate admission and intensive personalised care to ensure foetal and maternal salvage. Women with haemoglobin between 5 and 8 g/dl need to be screened for other problems and infections. In the absence of any other problem, most obstetricians administer required doses of iron by intravenous or intramuscular iron therapy[23, 52]. It has been reported that administration of 180-240 mg of elemental iron daily by oral route could also result in significant improvement of haemoglobin levels in anaemic women[19]. Difficulty in ensuring regularity of oral iron medication over months comes in the way of wider use of this simple, non-invasive method of treatment of anaemia.

High doses of iron often evoke unpleasant gastrointestinal side effects and so the patient compliance rates suffer. Under these circumstances, it would appear that the most acceptable alternative might be to administer maximum tolerated dose of oral iron and monitor compliance. Haemoglobin estimation after about a month would indicate whether oral iron therapy is improving haemoglobin levels. If this does not happen, a change over to parenteral iron therapy may have to be considered.

Women with haemoglobin levels above 8 g/dl also require oral iron folate medication to improve their haemoglobin status. The apparent lack of specific symptoms, and the long duration of medication, often result in women discontinuing iron intake during pregnancy. If the services of Community Health Volunteers could be used to ensure regular intake of iron folate medication especially among rural pregnant women, oral iron therapy may prove to be a useful method of tackling the problem of anaemia in rural areas.

In India anaemia antedates pregnancy and gets aggravated during pregnancy and labour. Repeated succession of rapid pregnancies and lactation perpetuate it. It is therefore essential that some attempts must be made to improve iron nutritional status of the entire community. Fortification of common salt with iron has been attempted as a method to improve iron intake of the entire population. The success of this programme in terms of improvement in haemoglobin status of the entire community had been demonstrated by the studies undertaken by the National Institute of Nutrition, Hyderabad[10]. It is possible that if salt fortified with iron is distributed throughout the country, the overall iron nutrition status of the entire population could be improved significantly over a period of 10 years.

Low dietary intake (< 20 mg/day) and poor iron absorption (five to 10 percent only) from habitually consumed cereal based phytate, fibre and tannin rich diets have been implicated as major factors responsible for anaemia. It is well recognised that the iron requirements of pregnant women from developing countries cannot be met by dietary iron. It is too difficult to change habitual diets of the entire community. Therefore, all non-anaemic pregnant women should receive 60 mg elemental iron and 500 μg of folic acid throughout pregnancy as a prophylactic measure.

An effective, multipronged approach to management of anaemia in pregnancy in developing countries must include: a) fortification of common food stuffs with iron to increase dietary intake of iron and improve haemoglobin status prior to pregnancy, b) early detection of all pregnant women in the community and screening them for anaemia, using a reliable method of haemoglobin estimation, c) oral iron folate prophylactic therapy for all non-anaemic pregnant women (haemoglobin more than 11 g/dl), d) iron folate oral medication at the maximum tolerable dose throughout pregnancy for women with haemoglobin between 8 and 11 g/dl, e) parenteral iron therapy for women with haemoglobin level between 5 and 8 g/dl if they do not have any obstetric or systemic complication, f) hospital admission and intensive personalised care for women with haemoglobin less than 5 g/dl, g) screening and effective management of obstetric and systemic problems in anaemic pregnant women, and h) improvement in health care delivery systems and health education to promote utilisation of available care.

Vitamin B Complex Deficiency In Pregnant And Lactating Women

It has long been recognised that anaemia and vitamin B complex deficiency are the two common specific nutrient deficiencies among low income group populations in developing countries. Unlike anaemia there have been very few studies to investigate vitamin B complex status[29, 30, 62] in different regions of India. This might be attributable to the fact that the currently available biochemical methods for assessment of vitamin B complex status are too costly, time consuming and difficult to be used in field surveys[20]. Though glossitis and angular stomatitis have been recognised as lesions suggestive of vitamin B complex deficiency[33] the lack of specific clinical grading system has come in the way of conducting prevalence studies in communities.

Recently a clinical grading system for assessment of lingual lesions associated with vitamin B complex deficiency has been evolved in the Institute of Nutrition[53], Using this clinical grading system a few large-scale studies had been undertaken to obtain data on prevalence of glossitis and angular stomatitis in women belonging to urban low income groups during pregnancy and lactation.

Studies carried out in the National Institute of Nutrition, Hyderabad, indicate that a majority of women from low income groups show biochemical evidence of deficiency of riboflavin and pyridoxine. However, only a small proportion of these women show clinical signs of vitamin B complex deficiency. Fever and diarrhoea often seem to precipitate occurrence of glossitis.

Studies among urban and rural income group show that glossitis was the most common clinical sign of vitamin 'B' complex deficiency in women. Prevalence of angular stomatitis was much lower. Incidence of glossitis and angular stomatitis progressively increased with increasing duration of pregnancy beyond 20 weeks. In lactating women both of these signs showed an increase with increasing duration of lactation beyond six months. With waning lactation there was decreasing prevalence of glossitis and angular stomatitis (Table 7).

Prevalence of glossitis was higher in primipara and grand multipara in Hyderabad. There was seasonal variation in prevalence of glossitis and angular stomatitis. Green leafy vagetables form the major source of vitamin B complex in the diet. Prevalence of glossitis was higher during the summer months when green leafy vegetables are costly and are not readily available[6, 50].

Studies on dietary intake of women with glossitis showed that there was a substantial reduction in dietary intake in women suffering from acute glossitis. This is most probably attributable to the burning sensation in the mouth. Glossitis and angular stomatitis respond readily to therapy with riboflavin. Following therapy with riboflavin repeat diet survey showed that dietary intake of the women returned to the levels comparable with those who did not have glossitis[6,7].

Comparison of nutritional anthropometric indices and haemoglobin status of women with glossitis with those not suffering from glossitis showed that body weights and haemoglobin levels were lower in women who were suffering from chronic extensive glossitis. These data suggest that chronic severe glossitis is most likely a reflection of continued inadequate dietary intake of all food stuffs including green leafy vegetables[7].

Unlike anaemia, vitamin B complex deficiency was not associated with any demonstrable functional decompensation such as immune depression, adverse impact on course and outcome of pregnancy.

It is obvious that there are many differences between vitamin B complex deficiency and anaemia though both are widely prevalent among women from low income groups. Vitamin B complex deficiency as diagnosed by presence of the clinical signs readily respond to short-term B complex therapy and is not associated with any adverse effect on pregnancy or lactation. Because of the symptoms women do seek medical practitioners and with treatment the clinical signs disappear rapidly. However, because of continued inadequate intake recurrences are common.

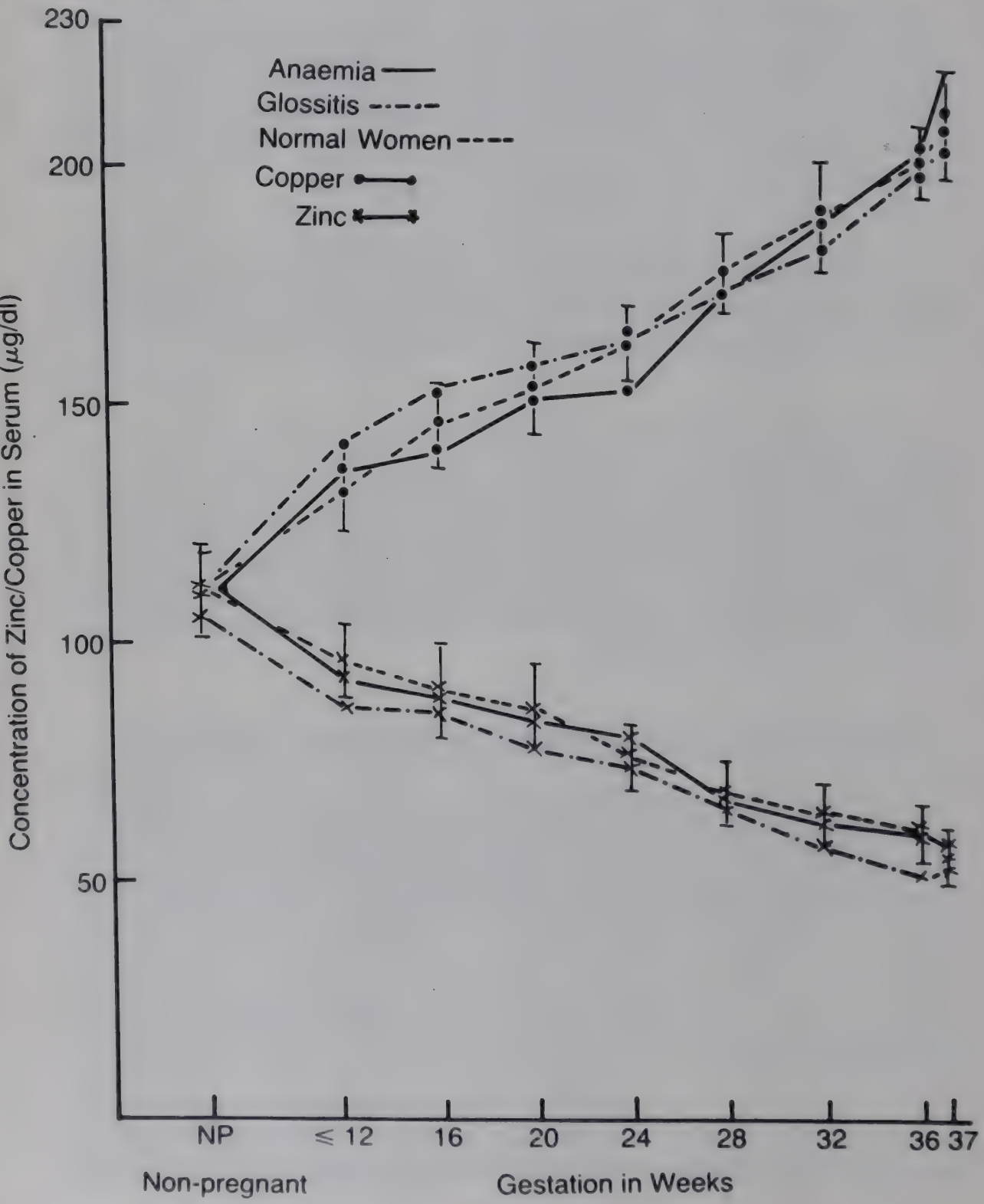
Copper And Zinc Nutritional Status During Pregnancy And Lactation

During the last two decades several studies have been undertaken to investigate the role of trace elements, especially copper and zinc, in human reproduction. There have been speculations whether the dietary intake of these trace elements are adequate, and if absorption of these is affected by the presence of inhibiting factors in habitual Indian diets. Following the reports of association between alterations in serum copper and zinc levels and a variety of obstetric problems including low birth weight, several investigators in India undertook studies to investigate copper and zinc status in pregnant and lactating women[15, 18, 41, 45, 48].

Studies undertaken at the National Institute of Nutrition, Hyderabad, indicated that in the habitual diets consumed in different parts of the country,

copper and zinc content of the diet were adequate to meet the nutritional requirements, provided the energy and protein requirements were met by dietary intake. Serum copper and zinc levels in non-pregnant, and non-lactating women were essentially similar to those reported from women who were well-nourished[48]. In pregnancy, there was a slow but steady increase in serum copper and a slow fall in serum zinc levels (Fig 1)[45]. There were no differences

Fig 1. Longitudinal Study of Trace Element Profile in Pregnancy



in serum copper and zinc levels between women from low and high income groups even under the stress of pregnancy. Serum copper and zinc levels in anaemic women and those having clinical signs of vitamin B complex deficiency were similar to those in normal women. There was no correlation between maternal serum copper and zinc levels and cord levels of copper and zinc.

Serial assessment of serum copper and zinc levels showed that there was a progressive decline in the serum copper levels and a progressive increase in serum zinc levels in the postpartum period. Levels comparable to those seen in non-pregnant women were reached by six weeks after delivery. Lactation for two years did not have any effect on serum copper and zinc levels. The copper and zinc levels in breast milk from low income group of women were essentially similar to those seen among well-nourished women.

The exact mechanism by which pregnancy induced changes in serum copper and zinc levels are brought about are not clearly understood. The rise in serum copper is thought to be due to estrogen-induced synthesis of ceruloplasmin and fall in zinc due to altered binding affinity of zinc proteins.

Estimation of maternal and cord blood levels of serum copper and zinc showed that there was no correlation between cord copper and zinc levels and birth weight[15]. The mean serum copper levels were lower and mean serum zinc levels were higher in mothers who gave birth to infants weighing below 2 kg. Because of the wide range in normal values of serum copper and zinc levels, these estimations were not useful in assessment of size of the baby or foeto placental function. Neither of these trace element levels were useful in predicting foetal abnormalities.

Although several investigators have reported association between alterations in serum copper and zinc levels in women with obstetric problems such as threatened abortion, pregnancy-induced hypertension and poor intrauterine growth, serum copper levels were not of any help in predicting or detecting pregnancy problems in 'at risk' individuals[45].

There had been speculations that trace element deficiency might be widespread and be associated with low birth weight among poorer segments of population in developing countries like India. It is, therefore, reassuring to note that there is no evidence of copper and zinc deficiency even among low income group pregnant and lactating women and those suffering from anaemia and vitamin B complex deficiency. The observed association between placental insufficiency and low birth weight below 2 kg might be atributable to the defective hormone production and consequent changes in serum copper and zinc levels rather than nutritional deficiency.

Nutrition And Health Consequences of Adolescent Pregnancies

The adverse consequences of teenage pregnancies have been very well documented in developed countries. However, in these countries, teenage conceptions often occur out of wedlock, in girls from the low income group with known high risk behaviours like smoking and drug addiction. It is difficult to find out how much of the observed poor outcome is due to the adverse environmental factors and how much is due to occurrence of pregnancy in teenage.

In India teenage marriages are the rule in rural and many urban areas; the reported mean age at marriage varies between 13-15 years in rural areas and 14-18 years in urban areas.

There is thus an opportunity to investigate in depth the adverse consequences, if any, of teenage conception per se in the Indian setting. Since early teenage marriages are also common, the question whether conception prior to 16 years differs in any way from conception during the subsequent years would also be investigated.

Analysis of data on maternal height and weight in primiparous women (both urban and rural) in relation to age at first conception showed that there were no significant differences in height between the groups. However girls who conceived before they were 16 weighed less and had lower mean haemoglobin levels than the other groups.

Some of the earlier studies had shown that age at menarche is delayed in severely undernourished girls until the height deficit is made up. This protective effect might account for the observation that there were no significant differences in maternal height, irrespective of age at conception.

The extra nutritional requirements of pregnancy coming close after the nutritional requirements for adolescent growth spurt might be the major factor responsible for the observed poor nutritional status of girls who conceived before they are 16 years of age.

The mean birth weight of infants born to girls below 16 years of age was lower. The perinatal and neonatal mortality rate among infants born to girls under 16 years both in urban and rural areas was higher. The mortality rates

were lowest among infants born to women between 20-29 years (Table 8)[1].

In teenagers successful initiation and continued lactation was the rule. The mean duration of lactation was about 16 months in urban and 20 months in rural areas. In spite of this the infant mortality rates were higher in infants born to girls below 16 years of age. Mortality rates were highest in infants born to girls under 16 years of age living in rural areas[3].

Lower maternal body weight, lower pregnancy weight gain, and higher prevalence of anaemia and possibly pregnancy-induced hypertension among girls who conceived before they were 16 might account for the observed lower mean birth weight and higher perinatal and neonatal mortality rate in these groups, both in urban and rural areas. The higher low birth weight rates, obvious deficiencies in child rearing practices of these young girls, and poor availability and utilisation of health care services, especially in rural areas,account for the high infant mortality rates.

Undoubtedly there is a very urgent need to create awareness regarding adverse consequences of early teenage conception and mobilise social support for strict implementation of laws regarding age at marriage. Until such time the early teenage pregnant girl should be considered as a very high risk group and provided with adequate nutritional and health care; her infant should also receive appropriate health care. The health personnel should be sensitised to the needs of this very vulnerable group who are unlikely to seek or utilise available health care that they urgently require.

Effect of age at first conception on adult height: Studies in experimental animals have shown that administration of estrogens during adolescence results in early closure of epiphysis and consequently shorter adult stature. In developed countries concern has been expressed about the possibility that use of steroidal contraceptives in teenagers might have a similar effect; so far no data is available to prove or disprove this.

In India teenage marriages are the rule and in rural areas early teenage pregnancies are common. It is not known whether endogenous steroid surge during adolescent pregnancy has any effect on adult stature. Two studies have been carried out to find out the impact, if any, of adolescent pregnancy on adult height. In the first study adult height of parous women between 20 and 35 years of age were recorded. The mean height was computed in relation to age at first conception. The mean height was essentially similar in all the groups, irrespective of age at first conception.[9]

Measurement of height at the time of first delivery in urban and rural women showed that there were no significant differences in maternal height in different age groups. The mean height of primipara were essentially similar to the height of parous women in their 20s.[9]

Nutrition And Health Consequences Of Malnutrition During Childhood

Chronic undernutrition from early childhood continuing through adolescence into adult life is common among poorer segments of population. There had been speculation about the adverse effects of undernutrition in childhood on reproductive performance. However there had been very few studies investigating this aspect because of major problems in mounting such a study. Follow up for about two decades is essential to obtain the data. If continued observation from early childhood till adult life is planned, these children would receive appropriate intervention during this period and benefit from it. Hence the group may not suffer from consequences which would occur in the absence of such intervention.

The National Institute of Nutrition, Hyderabad had a unique opportunity to obtain data on the effect of various grades of undernutrition during childhood on the reproductive performance. Nearly two decades ago a nutritional survey of all children under five years of age was carried out for five consecutive years in 26 villages near Hyderabad. These children were a part of a large cohort, in whom prevalence of vitamin A deficiency was investigated. All the children belonged to an essentially homogeneous rural population group, where environmental and health care interventions were minimal. None of the children received any major nutritional or health interventions during the study. After a lapse of seven years their growth status during adolescence was evaluated[4].

In these villages teenage marriages and conceptions were the rule. There were 912 girls belonging to the cohort who were traceable. An attempt was made to obtain information on:

- age at menarche
- age at marriage
- age at first conception
- nutritional status during pregnancy
- course and outcome of pregnancy
- lactational performance and
- survival and growth of the offspring in this group of girls.

The current nutritional status and reproductive performance were computed in relation to the childhood nutritional status.

There was a gradient in the mean age at menarche in the group, the well-nourished girls attaining menarche earlier than the undernourished ones. The age at menarche was delayed in girls who had suffered from severe undernutrition during childhood. Because of this delay, the severely undernourished girls made up the deficit in height observed through childhood and early adolescence. However they continued to weigh less than their better nourished counterparts.

Girls who were normally nourished or showed mild undernutrition during childhood got married at an earlier age than those who were moderately and severely undernourished during childhood. This might partly be attributable to the fact that in rural India, menarche is often followed by marriage within the next few months. Most of the normally nourished girls came from economically better off families; this might have resulted in their getting married at an earlier age.

These girls were followed up at least once during the first, second and third trimester of pregnancy. Information on changes in anthropometric indices of nutritional status, haemoglobin levels and course and outcome of pregnancy was collected. There was a significant difference in the mean height between normal and severely undernourished girls; nearly six percent of girls from the severely undernourished group had heights less than 140 cm, a risk factor associated with low birth weight and higher perinatal mortality rate. Girls who were normally nourished in childhood had a body weight comparable to rural low income group population throughout pregnancy. Girls who had varying grades of undernutrition during childhood weighed less (Table 9). The proportion of girls with body weight less than 40 kg was higher among those who had suffered moderate and severe undernutrition during childhood. In spite of differences in the pregnancy weight between normal and undernourished girls there were no significant differences in weight gain during pregnancy. Nor were there any differences in the mean haemoglobin levels or prevalence of moderate to severe anaemia between girls belonging to different grades of nutritional status during childhood.

Data collection regarding course and outcome of pregnancy showed that except for a marginally lower foetal loss rate in normally nourished girls, there were no significant differences in the course and outcome of pregnancy. The mean birth weight of infants born to these girls were comparable to those born to primipara in rural low income groups, except in the severely undernourished girls. The mean birth weight was lower and the proportion of

infants weighing less than 2.5 kg at birth was significantly higher among infants born to girls who were severely undernourished during childhood (Table 10).

It is, however, difficult to evaluate whether this is due to maternal nutritional status per se or due to co-existing adverse socio-economic and environmental factors. It is difficult to evaluate the relative contribution of higher proportion of low birth weight and adverse environmental factors in the observed increase in deaths during infancy among infants born to severely undernourished girls.

Lactation was successfully initiated in all these rural girls without any difficulty. The traditional pattern of unsupplemented lactation for periods up to six months was followed in all these women. There were no differences in the pattern of introduction of supplementary feeds to breast-fed infants. There were no significant differences in the mean body weight of infants born to girls suffering from various grades of malnutrition during childhood, during the first six months of age.

Nutrition And Health Consequences Of Conception During Lactation

Global studies have demonstrated that lactation prolongs postpartum amenorrhea and provides some protection against pregnancy, especially during the first few months. However, with increasing duration of lactation the contraceptive effect wanes. In India, among traditional urban and rural low income group women, prolonged lactation for about two years is quite common. Contraceptive use is not widespread. Available data indicate that about one-third of all pregnancies occur in lactating women. Some women stop breast-feeding as soon as they realise that they are pregnant. This tradition might have been evolved to protect the women from the dual stress of pregnancy and lactation. But such an abrupt cessation of breast-feeding may, however, have some adverse effect on infant/child nutrition. Substantial number of women continue to breast-feed their infants during pregnancy and face the nutritional and health consequences of the dual stress. In spite of the fact that conception during lactation and continued lactation during pregnancy are common, there have been very few studies investigating the problem.

Available data suggest that conception during the first year of lactation is relatively uncommon in India and occurs usually in working women and those who introduce supplements to the infant early i.e. before six months of age.

A majority of conceptions in lactating women occur during the second and third year of lactation (Table 11)[56].

Studies on dietary intake of women who had conceived during lactation have shown that their dietary intake is essentially similar to the dietary intake of non-pregnant women from similar income groups. The average calorie intake is no more than 1200-1600 Kcal/day; the diet is inadequate with respect to all nutrients. Obviously the dual stress of pregnancy and lactation may be expected to widen the already yawning gap between actual dietary intakes and nutrient requirements. Investigations undertaken by the National Institute of Nutrition, Hyderabad, indicate that irrespective of the duration of lactation, women who conceived during lactation weighed less in all the trimesters of pregnancy than those who conceived after lactation. The difference in body weight was more marked in the third trimester especially in the small group of women who had conceived during the first six months of lactation (Table 12). There were, however, no significant differences in the haemoglobin levels or prevalence of clinical signs of nutritional deficiencies between these groups.

Since all these women came from families with similar socio-economic status and had similar dietary intake, it is likely that the observed differences in body weight might be attributable to the dual stress of pregnancy and concurrent lactation. Women who conceived in the first six months of lactation fared worst because a) they did not have any time to recover from the stress of the previous pregnancy, b) the volume of milk secretion and nutrient loss in milk are greater in the first year of lactation and c) a substantial number of these women were working outside home and therefore had to face energy needs for work outside the house. It is obvious that conception during lactation does have an adverse effect on maternal nutritional status during pregnancy. Ensuring contraceptive care to lactating women would therefore constitute a non-nutritional intervention for reducing the magnitude of maternal undernutrition during pregnancy.

Morbidity in pregnant and lactating women: Ample data exist to indicate that pregnancy is associated with immunosuppression and that the prevalence of morbidity due to infection is, to some extent, higher in pregnancy. It is well documented that undernutrition is associated with increased susceptibility to infection. Since pregnant and lactating women are more undernourished than their counterparts who conceive after lactation, prevalence of morbidity due to infection might be higher in the latter group. However studies on prevalence of morbidity due to infection failed to show any increase in women who conceived during lactation. It is possible that under the existing conditions of poor environmental sanitation and immunosuppression due to pregnancy, the impact of a greater degree of undernutrition on morbidity rates was not obvious.

Reproductive performance: There were no significant differences in the past reproductive performances, or course and outcome of current pregnancy between those who conceived after lactation and those who conceived during lactation. However, mean birth weight was significantly lower in all women in whom the interpregnancy interval was less than 12 months (Table 13).

Infant growth and survival: Follow-up studies on health and nutritional status of infants born to women who conceived during lactation revealed that except for infants whose mothers had conceived during the first six months of lactation, there were no differences in the growth or survival of infants and children.

Studies from the National Institute of Nutrition (NIN) and elsewhere have shown that estrogens secreted in breast milk of oral contraceptive users exert biological effects on breast-fed infants. During pregnancy large amounts of estrogens are secreted by the placenta and circulated in the maternal blood During the survey undertaken by NIN specific attempts were made to look for such side effects but none of the infants and children examined showed any abnormality. So far, in world literature, there have not been any reported cases of side effects due to steroid ingestion through breast milk in pregnant and lactating women.

The reason for the absence of these side effects in spite of the fact that much greater amounts of steroids are circulating in blood is at the moment not clear and needs further exploration.

These studies have demonstrated that short interpregnancy interval and conception during lactation have adverse effect on maternal and infant nutrition, birth weight and infant survival. Ensuring adequate contraceptive care at the appropriate time to lactating women might therefore constitute an important non-nutritional intervention in reducing the magnitude of maternal undernutrition and poor pregnancy outcome among poorer segments of population in developing countries.

Nutritional Status And Reproductive Performance Of Working Women

Women's participation in economically productive activities outside home is not a new phenomenon. Women have been working along with their menfolk in the fields, right from the dawn of agriculture. Mankind has developed adaptive processes to ensure that occupation , in or outside the house,has no adverse effect on maternal nutritional status.

More and more urban and rural women in the developing countries are now seeking employment in non-traditional occupations outside the house because of socio-economic and other considerations. It is estimated that in India working women constitute about 12 percent of the total population and there is a trend towards increasing employment of women.

The type of work a woman does outside the house, availability of domestic help and economic factors might determine the impact of such employment on her. In some situations, dual stress and conflicting demands of work in and outside the house have been shown to have adverse effect on maternal and child health and nutritional status. On the other hand, employment outside the house may bestow upon the working woman and her family such benefits as rise in purchasing power and standard of living, with consequent improvement in nutritional status. Working women may have easier access to MCH care and family welfare facilities, with opportunities to utilise the same more effectively. The net impact of such beneficial and adverse effects of women working outside the house, might vary in different communities depending upon the prevailing conditions of work and home environment[55].

During the last few years, some pilot studies have been conducted to explore the impact of work outside home, on family formation patterns, nutritional and health status of working women in urban and rural areas. In all these studies housewives whose husbands are working in similar jobs as the husbands of working women formed the control group against which comparisons were made.

Urban Working Women

High and middle income groups: In urban high and middle income groups there is an increasing tendency among women to seek employment outside house. Some women have been working prior to marriage and continue to work through years of child bearing and child rearing. Others go to work after their children have grown up and have started going to school. Both these groups were compared to women who were not working outside the house.

The per capita income, standard of living, expenditure on childrens' education and investment in long term financial security measures were highest among the first group and lowest among housewives' families. Women in all the three groups were moderately active and had assistance available for household work.

The mean age at marriage of the group of women who worked all through was higher, and such women had fewer children. There were no significant differences between working women and housewives with respect to the health and nutritional status of either the mothers or their children.

These data suggest that in these segments of population, working outside the house does not have any adverse effect on health and nutritional status of either the mother or her children. The income generated by women's employment brought long term benefits like financial security after retirement and better education for children.

Lower middle income group: As expected, the per capita income was higher in working women's families. Children were sent to better schools and school dropout rates were lower in the families of working women. These families spent more money on long term security such as housing, provident fund and consumer goods which improved the standard of living.

Contrary to expectations, joint families were not more common among working women. All working women reported that child care, especially in the first five years, was difficult. Creches at workplaces or near their homes were used or baby sitters employed. Provision of day care centres for children was a 'felt' need among these working women. Help in household work was limited and most women did almost all household work themselves.

Compared to the housewives, working women got married at a significantly later age and had fewer children for any given age. Working women used contraceptives and resorted to medical termination of pregnancy (MTP) more often than the housewives. This might partly be due to the fact that they have greater awareness and access to contraceptives and MTP services.

Initiation of lactation was universal among both working women and housewives. Working women tended to introduce dietary supplements to infants earlier. The duration of lactation was unaffected by work outside the house, if they work in places where facilities like creches and time allowed for breast-feeding are available. If not, lactation gets curtailed with all its attendant adverse consequences.

When low middle income group women, working in jobs that are either sedentary or require moderate physical activity were investigated, working women were heavier and had higher values for skin fold thickness and mid-

arm circumference than housewives. It is possible that greater purchasing power had resulted in an improvement in food intake. Obviously in this segment of population gainful employment of women results in financial benefits and improvement in maternal nutritional status.

Low income group: The data for these studies had mainly been collected from women who took up employment as domestic servants, office cleaners or attendants. Husbands of the working women as well as of the housewives were employed as semi-skilled or unskilled labourers. The combined incomes of husband and wife in the working women's families were essentially similar to the earnings of the husband alone in families with no working women (housewives).

In both the groups, over 90 percent of the family's income was used up for providing the essentials — food, clothing and shelter. There were no differences in the living standards between the families of working women and housewives.

Patterns relating to age at marriage, reproductive performance and contraceptive use were similar among the housewives and working women. Perhaps because the working women were actually employed only as and when there was a demand for unskilled workers, they did not feel that repeated child births came in the way of their employment. These women, especially domestic servants, took their children with them to the place of work. So prolonged successful lactation was the rule even among these working women.

The group of working women investigated in these studies were employed in jobs that demanded only moderate physical activity. Data from the study suggest that this type of work outside the house did not have any adverse effect on maternal nutritional status or lactation. Information on health and nutritional consequences of heavy manual labour among women has to be obtained for designing appropriate intervention programmes to minimise the possible adverse consequences.

Working Women In Rural Areas

In most of the rural areas, women from the middle income group do not work outside home. But almost all women from low income families are employed in sowing, weeding, transplanting and harvesting work. Only a few

women from families of landless labourers find gainful employment in other seasons also. Almost all housewives do look after cattle and poultry. Thus in rural communities it is very difficult to find housewives who come from a similar socio-economic background as the working women for studying the impact of work outside home on health and nutritional status.

Studies comparing housewives and working women in rural areas indicate that working women in rural areas came from less educated and economically poorer segments of the village community. A majority of them were working as unskilled labourers on the farms. In spite of their employment, the per capita income of these families remained lower than that of families where women were not working outside the house.

There were no significant differences in family formation pattern, obstetric, lactational performance or contraceptive use between women working outside the house and those who were housewives.

Women working outside the house were lighter and had lower skinfold thickness than housewives (Table 14). This might be due to general poverty, lower purchasing power and lower dietary intake in the face of strenuous manual labour.

Data from these studies indicate that gainful employment of urban women outside the house is associated with (i) improved financial status in urban high and middle income groups, (ii) improved maternal nutritional status in the lower middle income group and (iii) prevention of deterioration of nutritional status due to poverty in the urban low income group.

Rural working women are undernourished and overworked. It is not possible for them to refrain from working outside the house because, if they do so, their families would have a still lower economic status and purchasing power. Intervention programmes aimed at augmentation of their income and ensuring sustained employment throughout the year might result in mitigation of the observed adverse effect of work outside the house on nutritional status of women. Attempts should also be made to explore the provision of drinking water facilities near home, biogas plants and other energy-saving, drudgery-reducing measures that would help these overworked women.

A very large number of the urban low income group of women are employed in the unorganised sectors of various industries. A majority per-

form unskilled heavy manual work such as building, construction, road repair and stone cutting. In these situations women have to continue to do heavy manual work throughout pregnancy in order to earn wages and buy food. Working conditions often leave much to be desired. For instance, in hot tropical countries, road building works inevitably imply heavy thermal stress. These women are also exposed to asphalt fumes in heavy concentration. What is the impact of a combination of thermal stress, exposure to hydrocarbons, heavy manual labour and inadequate dietary intake during pregnancy? We do not have any information to answer these questions. The urban woman workforce is growing at a very rapid rate in all developing countries. It is necessary to investigate and find out the effect of this non-traditional manual work on reproductive performance, so that necessary remedial measures could be taken up before the problem becomes too big to cope with.

In recent years several small scale industries, employing predominantly women, have come up in many developing countries. This type of work calls only for moderate physical activity. *Beedi*, joss stick, match and coir are examples of these types of industries. Since women working for wages is inevitable due to economic pressure, many organisations advocate employment in such industries for women with the belief that moderate activity does not entail large energy expenditure and is not harmful. It is true that work in these industries involves only moderate physical activity. But most often wages are based on output of products. As the activity is not physically very taxing, these women tend to work for longer hours. In addition there are the problems of uncomfortable body postures, troublesome physical injuries and exposure to various chemicals. There is, at the moment, no information regarding energy needs, expenditure or course and outcome of pregnancy in women working in these types of industries. Needless to say indepth studies are essential to obtain data and plan appropriate preventive and remedial measures for the rapidly expanding woman workforce in these sectors.

Summary

Among poorer segments of population in developing countries, mild and moderate degrees of maternal undernutrition continue to be widely prevalent. A majority of women in these segments of population consume only 12 to 16 kilo calories per day throughout their reproductive years. Their pre-pregnancy weight ranges between 40-45 kilograms and their pregnancy weight gain about 6 kilograms. Birth weight of offspring in these communities ranges between 2.5 and 3 kilograms. Due to effective but ill understood adaptive processes, the continued low dietary intake during pregnancy does not cause deterioration in maternal nutritional status provided: a) interpregnancy interval is over two years, b) there is no further reduction in habitual dietary intake, c) no increase in physical activity.

Chronic moderate maternal undernutrition and anaemia have been shown to be associated with adverse outcome of pregnancy. Food supplementation coupled with adequate treatment of anaemia and antenatal care for detection and prompt treatment of obstetric problems in this high risk group would ward off these adverse effects.

The additional stress of lactation during pregnancy results in deterioration of maternal nutritional status especially when the interpregnancy interval is less than one year. Contraceptive care initiated at the appropriate time during lactation would go a long way in preventing adverse effects of continued lactation during the subsequent pregnancy.

Among rural low income group women whose dietary intakes are low, continued manual labour in agricultural operations has an adverse effect on maternal nutritional status during pregnancy. Food supplementation programmes especially in the preharvest season may help in maintaining the dietary intake at habitual levels. Inexpensive innovative labour-saving devices which can reduce physical work in common household chores may also be effective in preventing deterioration in maternal nutritional status.

Table 1

Birth Weight and Socio-economic Status

	No.	Age (yrs)	Parity	Height (cms)	Weight (kg)	Hb (g/dl)	Birth weight (kg)
Poor income	1468	24.1	2.41	151.5	45.7	10.9	2.70
Middle income	108	24.3	1.96	154.2	49.9	11.1	2.90
High income	63	27.8	1.61	156.3	56.2	12.4	3.13

Table 2

Changes in Body Weight during Pregnancy (Semi-longitudinal Data):Urban Low Income Group

	Duration of pregnancy (weeks)								
	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40	Pre-pregnancy weight
Weight (kg)	42.8 ± 6.86 (20)	43.4 ± 5.67 (71)	44.1 ± 6.12 (134)	45.3 ± 5.80 (260)	46.8 ± 5.92 (384)	48.0 ± 5.94 (465)	49.8 ± 6.14 (364)	50.7 ± 5.97 (278)	44.4 ± 7.76 (205)

Values are Mean ± S.D.

Figures in parentheses indicate number of observations.

Table 3

Anthropometric Indices of Nutritional Status in Rural Pregnant Women

Group	Height (cm)	Weight (kg)	Arm circumference (cm)	Fat fold thickness (mm)
	A	B	C	D
1. Nonpregnant non-lactating (1907)	150.4±5.29	42.3±7.02	22.5±2.41	10.5±4.73
2. First trimester (88)	150.1±5.51	41.5±6.98	22.2±2.68	9.6±4.12
3. Second trimester (771)	150.4±5.70	44.6±6.72	22.1±2.01	9.7±3.72
4. Third trimester (1658)	150.3±5.49	46.0±8.67	21.7±1.92	9.2±3.49

Values are mean±SD

Figures in parentheses indicate number of observations.

		A	B	C	D
't' test	*1vs 2*	*NS*	*NS*	*NS*	*P<0.01*
	1vs 3	NS	*P <0.001*	*P <0.001*	*P <0.001*
	1vs 4	*NS*	*P <0.001*	*P <0.01*	*P <0.001*

Table 4

Haemoglobin (Hb) Levels in Different Periods of Gestation

Group (Gestational age in weeks)	Urban		Rural	
	No.	Hb (g/dl)	No.	Hb (g/dl)
Nonpregnant nonlactating	2404	11.8 ± 1.72	204	10.8 ± 1.92
≤ 8	449	11.8 ± 1.92	31	10.8 ± 1.76
9 – 12	598	11.4 ± 1.91	31	10.6 ± 1.74
13 – 16	772	11.1 ± 1.91	104	10.2 ± 1.64
17 – 20	744	10.8 ± 1.79	132	9.7 ± 1.72
21 – 24	761	10.6 ± 1.76	94	9.3 ± 1.65
25 – 28	751	10.4 ± 1.82	134	9.0 ± 1.71
29 – 32	1792	10.3 ± 1.92	164	9.0 ± 1.72
33 – 36	2042	10.5 ± 1.84	141	9.4 ± 1.75
37 – 40	1690	10.7 ± 1.96	191	9.6 ± 1.81

Table 5

Effect of Maternal Haemoglobin Status on Birth Weight and Perinatal Mortality

	Haemoglobin (g/dl)			
	<5.0	5.0-7.9	8.0-10.9	≥11.0
No. of cases	312	443	1202	1783
Mean birth weight (g)	2400± 810	2530± 651	2660± 544	2710± 496
Prematurity (%)	34.5	18.2	12.5	10.2
Birth weight <2500 g (%)	62.3	38.4	26.4	23.1
Perinatal mortality (rate/1000 births)	400.6	130.9	64.1	44.9
Groups	(4)	(3)	(2)	(1)

χ^2 test for prevalence of prematurity, low birth weight and perinatal mortality rate in different groups

	Prematurity	Birth weight <2500 g	Perinatal mortality rate
1 Vs 2	NS	P<0.05	P<0.05
1 Vs 3	P<0.001	P<0.001	P<0.001
1 Vs 4	P<0.001	P<0.001	P<0.001

Table 6

Immune Status of Anaemic Pregnant Women

	Maternal haemoglobin (g/dl)		
	5.0 – 7.9	8.0 – 10.9	≥ 11.0
% B Cells	16.3 ± 1.39[a] (36)	19.9 ± 1.58[b] (34)	22.8 ± 1.72[b] (36)
% T Cells	46.8 ± 1.66[a] (38)	52.4 ± 1.54[b] (44)	57.5 ± 2.16[b] (35)
PILT, (T/C ratio)	8.5 ± 1.30[a] (31)	7.9 ± 0.91[a] (47)	7.9 ± 1.20[a] (32)
Immunoglobins (mg/dl)			
IgG	1866 ± 153.8[a] (15)	1216 ± 55.1[b] (13)	872 ± 55.3[c] (20)
IgA	272 ± 29.6[a] (15)	190 ± 25.1[b] (13)	207 ± 18.8[b] (20)
IgM	148 ± 13.4[a] (15)	118 ± 9.6[a] (13)	122 ± 13.0[a] (20)

Values are mean ± S.E.
Figures in parentheses indicate number of women studied.
Means not carrying common superscripts are significantly different.

Table 7

Prevalence of Glossitis and Angular Stomatitis (prevalence rate/1000)

Group	Glossitis	Angular stomatitis
Nonpregnant nonlactating (NPNL) (control group)	172	46
Pregnant women	211	68
< 20 wk (P_1)	143	41
20-29 wk (P_2)	224	63
≥ 30 wk (P_3)	267	101
Lactating women	238	80
Duration of lactation		
≤ 6 months	222	45
7-12 months	261	74
> 12 months	232	98
(a) Baby mainly on breast milk	268	121
(b) Baby mainly on weaning food	192	64

Results of intergroup comparision *

	Glossitis	Angular stomatitis
NPNL vs. P_1	NS	NS
NPNL vs. P_2	$P < 0.05$	NS
NPNL vs. P_3	$P < 0.001$	< 0.001
NPNL vs. lactation ≤ 6 months	NS	NS
NPNL vs. lactation 7-12 months	$P < 0.02$	NS
NPNL vs. lactation < 12 months	NS	$P < 0.05$
NPNL vs. (a)	$P < 0.001$	$P < 0.001$
NPNL vs. (b)	NS	NS

* *Results are based on X^2 test of significance.*

Table 8

Effect of Age and Parity on Foetal Loss and Infant Mortality Urban (U) and Rural (R) Low Income Group

Group (age in years)	Gravida	No. of pregnancies		Abortion (% of pregnancies)		Perinatal mortality (rate/1000 births)		Neonatal mortality (rate/1000 live births)		Infant mortality (rate/1000 live-births)	
		U	R	U	R	U	R	U	R	U	R
<16	1	378	625	3.4	3.1	109.9	114.7	68.8	138.8	96.5	197.6
	2-4	74	106	3.3	2.8	103.7	102.8	62.2	131.4	84.7	186.7
16-19	1	596	878	5.7	3.3	79.8	78.4	67.5	74.6	94.5	140.5
	2-4	876	1106	7.5	5.0	48.7	40.6	52.1	68.8	80.8	126.7
20-24	1	640	168	5.3	3.6	64.7	60.7	58.6	53.4	73.2	74.6
	2-4	1472	1278	10.2	4.3	32.6	29.6	18.6	25.4	32.1	68.2
	⩾5	172	184	12.9	4.7	48.2	38.7	28.7	29.8	35.8	62.2
25-29	1	198	–	6.3	–	66.8	–	53.2	–	71.5	–
	2-4	608	396	15.0	3.9	34.6	34.6	17.7	28.8	29.8	65.7
	⩾5	305	364	20.6	4.9	54.6	45.5	32.3	40.3	42.3	97.8

Table 9

Nutritional Status of Pregnant Women During the Third Trimester of Pregnancy

Group (according to childhood nutritional status)	Height (cm)	% with less than 140 cm	Weight (kg)	% with less than 40 kg	Arm circumference (cm)	Skinfold thickness (mm)	Haemoglobin (g/dl)	% with haemoglobin <8.0 g/dl
Severely undernourished	148.6±1.02* (25)	5.9	46.3±1.04 (27)	35.3	20.30.44 (27)	9.5±0.50 (27)	9.4±0.36 (20)	11.8
Moderately undernourished	151.5±0.78 (44)	–	46.3±0.79 (37)	40.0	21.5±0.26 (37)	9.7±0.41 (35)	9.5±0.32 (17)	11.1
Mildly undernourished	150.9±0.78 (38)	1.6	47.2±0.87 (45)	18.0	21.5±0.26 (45)	10.6±0.50 (45)	9.7±0.29 (28)	4.9
Normal	155.7±0.99 (25)	–	50.2±1.12 (25)	6.7	21.9±0.33 (24)	10.0±0.75 (12)	9.3±0.39 (15)	10.0

Values are mean ± S.E.

Figures in parentheses indicate number of women

**P <0.05 as compared to normal.*

Table 10

Maternal Nutritional Status and Outcome of Pregnancy

Group (according to nutritional status in childhood)	Foetal loss %	Birth weight (kg)	Birth weight below 2.5 kg (%)	Death during infancy %
Severely undernourished (37)	11.8	2.41±0.090	52.9	11.8
Moderately undernourished (49)	8.9	2.57±0.065	42.2	8.9
Mildly undernourished (66)	8.2	2.55±0.057	37.1	3.3
Normal (30)	3.3	2.62±0.089	38.3	6.9

Values are mean ± S.E.
Figures in parentheses indicate numbers.

Table 11

Conception During Lactation

Duration of lactation	No. conceived	Conception Rate %
< 12 months	121	15.8
12-23 months	257	33.6
⩾ 24 months	396	51.6
Total	764	100.0

Table 12

Anthropometric Indices of Nutritional Status in Pregnant Women Who are Also Lactating (Third Trimester)

Groups			
Duration of lactation (months)	Period of Gestation (months)	Height (cm)	Weight (kg)
Not lactating	Third trimester	150.8 ± 4.27 (1522)	49.5 ± 5.12 (1522)
≤12	"	149.2 ± 6.13 (9)	41.9 ± 3.20 (8)
13-24	"	149.9 ± 4.49 (66)	47.1 ± 6.19*** (66)
>24	"	148.8 ± 5.32 (31)	46.9 ± 7.27** (32)

****P*<0.001 ***P*<0.01

Table 13

Effect of Conception During Lactation on Birth Weight of Infants

	Interpregnancy interval (months)		
	≤ 12	13-24	≥25
	Birth Weight (kg)		
Pregnant	2.62 ± 0.385 (603)	2.82 ± 0.421 (1371)	2.80 ± 0.439 (1950)
Pregnant women who were lactating	2.58 ± 0.398 (93)	2.80 ± 0.413 (217)	2.78 ± 0.429 (310)

Figures in parentheses indicate number of women.

Table 14

Nutritional Status of Rural Women (Low Income)

Group		Height (cm)	Weight (kg)
Non-pregnant	Working women (469)	149.9±5.26	41.5±6.76 ***
	Housewives (426)	151.3±5.84	43.4±7.62
Pregnant	Working women (325)	150.1±5.33	43.5±3.17 ***
	Housewives (348)	150.9±5.93	45.6±6.35
Lactating	Working women (392)	149.4±6.37	41.1±3.82 ***
	Housewives (321)	150.8±5.52	42.9±7.05

Figures in parentheses indicate number of women

P Values ***$P<0.001$

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Lactation – Nutrition – Fertility Interaction

Prema Ramachandran

The importance of breast feeding in infant nutrition and survival has long been recognised. The recognition that lactation may have profound effects on maternal nutrition and fertility is of a more recent origin. Maternal nutrition may affect lactational performance and lactation may have some effect on maternal return of fertility after delivery. The advent of the next pregnancy, or contraceptive measures used to avoid this, may have an effect on lactation and maternal nutritional status. A brief review of some of the studies exploring lactation – nutrition – fertility interaction is given in the following pages.

Effect Of Lactation On Maternal Nutrition

Dietary intake and anthropometric changes during lactation: Successful prolonged breast feeding for 18-24 months is the traditional practice among poorer segments of population in India. The recognition of the importance of breast feeding in infant survival, growth and nutrition in poorer segments of the population in developing countries has resulted in efforts to strengthen the existing practice of prolonged lactation in these segments of the population. Lactation involves considerable nutrient expenditure for the mother; the estimated calorie expenditure varies between 400-700 Kcal/day[6]. Available information suggests that, unlike well nourished women from developed countries, in undernourished women there is no deposition of body fat during pregnancy, to meet the extra needs during lactation.

Data obtained from the diet surveys indicate that the majority of lactating women subsist on diets which provide 1,200-1,600 Kcal/day[14,15,17,18,21,25,29,43] (Table 1). Their dietary intakes provide no more than half of the recommended dietary allowances with respect to calories.

Even assuming that they secrete no more than 500-600 ml of milk per day and assuming that the calorie cost of milk production is 80 Kcal/100 ml the calorie expenditure involved in milk production per se is about 450-500 Kcal per day. The net energy thus available for a moderately active lactating mother is only 800 Kcal/day. Under normal circumstances such a large energy deficit is likely to result in weight loss of about 1.5-2.0 kg per month.

Studies of anthropometric indices in lactating women indicate that the mean body weight, mid-arm circumference and skinfold thickness at triceps showed a progressive fall with increasing duration of lactation in women whose infants were mainly on breast milk. The mean body weight of women whose infants were mainly on solid food but who received two or three breast feeds a day was higher than that of women whose infants were mainly breast fed and more comparable to that of non-lactating women[29](Table 2).

Data from these studies indicate that a majority of women from low income groups subsist on 1,000-1,600 Kcal per day, irrespective of whether they are lactating or not. They continue to do household work, look after their children and often do some manual labour to earn money whether they are nursing or not. The alterations in body weight during lactation are of too small a magnitude to make any difference in energy needs. Thus energy intake and two factors that govern energy expenditure i.e. body weight and physical activity, remain unaltered. It would appear that the habitual dietary intake is just sufficient to maintain body weight in non-lactating women. It is sufficient to prevent marked weight loss in spite of added expenditure of about 500 Kcal per day during the first year of lactation. It is sufficient enough to cause a weight gain during later months of lactation when energy loss in milk production decreases. But with the cessation of lactation it is again no more than adequate for maintenance of body weight. Obviously some ill understood but exquisitely sensitive adaptive changes occur in lactating women on fixed energy intakes, so that the energy balances is maintained in spite of marked variations in energy expenditure.

An important concept regarding energy utilisation is that only a portion (maximum of 30-40 percent) of the total energy is converted into ATP or similar high energy compounds and is available for physical work or anabolic process. It has been suggested that efficiency of utilisation might be higher when dietary intakes are lower. It is also possible that efficiency of energy utilisation may be modified by physiological changes known to occur during lactation and pregnancy. Ample data exist to indicate that plasma prolactin levels are higher and remain at the elevated level throughout the period of lactation in women from undernourished communities. It has been speculated whether high prolactin levels may play a vital role in ensuring preferential transfer of nutrient to breast milk in undernourished women. It is also possible that ele-

vated prolactin levels may have an anabolic role and result in more efficient utilisation of available nutrients by the mother. This hypothesis if proved will, to a large extent, explain the reported changes in body weight in lactating women[29].

It is essential that studies on energy balance in lactating women under varying conditions of intake and life style should be undertaken to provide the basis for determining RDA in lactating women. Such studies are costly, time-consuming and difficult. But in view of the social, economic and health implications, it is essential that such studies are undertaken to provide an accurate asessement of the nutritional needs of this vulnerable segment of the population under existing conditions.

There are, however, limits beyond which these adaptive mechanisms cease to be effective. Studies from India have shown that the advent of the next pregnancy in lactating women results in deterioration in maternal nutritional status[42]. Studies from Gambia[35] have demonstrated that a further fall in dietary intake below the habitual level — especially when coupled with increase in physical activity as in the preharvest season — results in deterioration in maternal nutritional status and reduction in milk output. It is therefore essential to ensure that dietary intake does not fall below habitual levels. Providing simple technologies to reduce physical activity in these women and providing contraceptive care are two non-nutritional measures that might go a long way in preventing deterioration in maternal nutritional status in lactating women.

Effect of food supplementation during lactation: Lactating women had been considered a nutritionally vulnerable group because of the obvious nutrient loss in milk production. Lactating women have therefore been one of the target groups for food supplementation programmes. In recent years some research workers have attempted to evaluate the impact of such food supplementation programmes. Available data suggest that there is no substantial improvement in maternal nutritional status even in carefully supervised food supplementation studies which resulted in a substantial increase in maternal dietary intake[35]. Food supplementation did not result in any increase in quanlity of milk secreted or improvement in quality of milk produced[12,16,35,36]. It has been suggested that the additional food intake might have been utilised for reversal of adaptive changes and hence not associated with any improvement in maternal body weight.

Recent studies from Gambia had confirmed that food supplementation to lactating women did not result in improvement in body weight. However, during the wet season when reduction in habitual dietary intake and increased

work output usually resulted in deterioration in maternal body weight and reduction in milk output, food supplementation prevented these adverse effects[35,36].

These studies also brought to light an interesting side effect of maternal food supplementation. Food supplementation resulted in faster return of fertility in lactating women[22]. Several epidemiological studies had documented the association between faster return of fertility and better maternal nutrition. The demonstration that food supplementation to undernourished women results in faster return of fertility emphasises the need for providing concurrent contraceptive care to ensure that early advent of the next pregnancy does not result in deterioration in maternal nutritional status.

Effect of lactation on vitamin and mineral status: With the reversal of pregnancy-induced hydraemia and persistence of pregnancy-induced increase in haemoglobin (Hb) mass, lactating women have higher Hb levels during the early months of lactation. There is a progressive fall in the mean Hb levels with increasing duration of lactation. After 18 months the Hb levels in lactating women are comparable to those seen in non-lactating women[30] (Table 3). It is surprising that in spite of the fact that lactating women do not menstruate for about 10 months and iron loss through milk is negligible, there is a progressive fall in Hb levels. Some consider this physiological, in the sense that Hb levels return to those seen in the pre-pregnant state. Others have speculated that this could be due to folate loss in milk and consequent deterioration of maternal folate status. Studies undertaken to evaluate plasma and RBC folate status in lactating women indicate that there was no deterioration in plasma or RBC folate levels with increasing duration of lactation nor was there any change in iron status[1]. Lactation does not cause any deterioration in serum trace mineral levels.

Vitamins of the B-complex group are involved in milk production and also get excreted in milk. It was, therefore, hardly surprising to find that the prevalence of glossitis and angular stomatitis was higher in lactating women. Prevalance of glossitis increased with increasing duration of lactation. It was higher in women whose infants were mainly breast fed[33]. Both the duration of lactation and the quantity of breast milk secreted appear to determine the prevalence of vitamin B-complex deficiency. Biochemical evidence of riboflavin and pyridoxine deficiency was widespread in women from low income groups and lactation was associated with higher prevalence of deficiency of these vitamins[2].

Data so far presented show that lactation does have a deleterious effect on maternal nutritional status. It is therefore essential that efforts should be made to improve nutritional status of lactating women.

Effect Of Maternal Nutrition On Lactation

The effect of maternal nutrition on lactation has long been a subject of speculation. Some believed that maternal undernutrition would not have any adverse effect on lactation, because lactation has been evolved as a method of ensuring adequate nutrient intake for the vulnerable young infant. Others argued that maternal nutritional status will inevitably have some impact on quantity and quality of milk secreted by the mother. During the last three decades scientists belonging to various disciplines had extensively investigated this thorny issue.

In these studies, maternal socio-economic status, dietary intake, body weight and various biochemical indices have been used as indicators of maternal nutritional status. Successful establishments of lactation, duration of lactation, growth of breast fed infants, quality of milk secreted and composition of breast milk have been used as parameters to assess the impact of maternal nutrition on lactation.

Volume of breast milk: Does maternal nutrition affect quantity of milk produced? The answer to this seemingly simple question has been eluding research workers for the last three decades. Two methods have been widely used for measurement of breast milk volume – manual expression and 'test feeding'. The former gives an idea about the total quantity of milk produced while the latter provides the vital information on how much milk the baby ingests. Both these methods for assessment of quantity of breast milk are tedious, time consuming and have to be done with meticulous care in order to obtain replicable results.

Studies conducted in the National Institute of Nutrition during the early 1960s had shown that undernourished Indian women secrete 500-800 ml milk/day[11,12,17,18]. More recent studies using electronic balances for measurement of milk intake of infants have confirmed these findings. Reports from the developed countries indicate that milk intake of infants in these countries range from 600-1,000 ml/day but milk intake of infants born to undernourished women was lower[7]. The data suggest that the quantity of milk produced by undernourished women from developing countries is less than that of well nourished women from developed countries.

In recent years the concept that the infant modulates maternal milk yield has gained wide acceptance. Infants of undernourished women weigh less

from birth through infancy compared to those born to well nourished women. The nutrient needs for these smaller infants are likely be lower and this may at least be one of the reasons for the lower volume of milk ingested by these infants. Data from some of the WHO collaborative studies have shown that when infants of similar birth weight and body weight were investigated, there were no significant differences in volumes of milk produced between undernourished and well nourished mothers, supporting the hypothesis that infant size is one of the determinants of volume of breast milk produced.

During the last five years two innovative methods of measuring volume of milk ingested by the infants namely deuterium oxide dilution and measurement of flow rates through the nipple shield have been developed. With the advent of these methods, it has become possible to undertake large scale community-based studies on breast milk volume. It is hoped that with these advances, it will be possible to undertake studies documenting the relative role of maternal nutrition and infant weight in determining the volume of milk secreted.

Composition of breast milk: Efforts to investigate the effect, if any, of maternal nutritional status on milk composition began in the '50s. It soon became obvious that apart from the substantial differences in the macro-nutrient content between hind and foremilk, there were diurnal and day variations in composition of breast milk. Therefore, in studies aimed at finding out the impact of maternal nutrition on nutrient content of breast milk, special efforts have to be made to ensure that milk samples are collected using uniform protocol taking all these variations into account.

Available data from studies conducted in the '50s and '60s in India indicated that milk secreted by undernourished women had a somewhat lower fat content; protein levels were similar to those reported in well nourished women[11,12,17-21]. In spite of the differences in the fat content there were no significant differences in the calorie content of milk secreted by undernourished and well nourished women because in the former group the lactose content was higher. Subsequent studies in India and global studies have confirmed these observations[7].

Most of the available data suggest that food supplementation to undernourished women does not have any significant impact either on quantity or macro-nutrient composition of breast milk[7, 12, 16, 18, 35]. However, data from Gambia have shown that food supplements given during the wet season could arrest the reduction in milk volume during this season[36].

There had been speculations about the possible impact of these differences in milk composition on infant nutrition and development. Available data suggest that these marginal differences do not have any impact on infant growth and development. It is possible that nature has ensured that calorie content of breast milk remains unaltered by maternal undernutrition, so that infant growth is safeguarded. It is also possible that infants can adapt themselves and thrive even when composition of their diet varies substantially. Infant food formulae in the '40s and '50s had low fat, high protein and high sugar content. Infants fed on these grew well and have reached middle age without showing any abnormalities attributable to their diet during infancy. Whatever may be the mechanism, available data suggest that the observed alterations in macro-nutrient composition of breast milk in maternal undernutrition do not have any adverse impact on infant growth.

Studies on mineral and trace mineral content of breast milk have shown that there are no significant differences between milk secreted by well nourished and undernourished mothers[37]. However, levels of almost all vitamins, both water soluble and fat soluble, appear to be lower in milk secreted by undernourished women[7,9,10]. Supplementation of vitamins to the lactating women led to improvement in vitamin content of milk. Majority of undernourished women from the low income group in India show biochemical evidence of vitamin deficiencies. It is therefore hardly surprising to note that their breast milk contains lower concentration of these vitamins. The nutritional consequences of this on breast fed infants are still not clearly understood and need to be investigated.

Duration of lactation: Studies undertaken during the '50s in India showed that undernourished rural women successfully initiate lactation and continue to breast feed their offspring for periods up to 24 months[17,18]. Several global studies[4,5] and studies from India have confirmed these observations[13,40]. These data suggest that maternal undernutrition does not have any adverse effect either on initiation of lactation or duration of lactation. Prolonged successful lactation appears to be nature's protective evolutionary step to look after the nutritional needs of the vulnerable young infant in communities where poverty and undernutrition are common.

Infant growth: Studies from India have shown that solely breast fed infants grow well during the first three months of life; their growth during this period is comparable to that observed among infants born to well nourished mothers[3] (Table 4). Solely breast fed infants from low income groups double their birth weight by six months of age indicating that breast milk alone is adequate to support infant growth in early infancy[38]. However, after six months, growth faltering is very common (Table 4). Delay in introduction of

supplementary foods to infants (Table 5) and prevalence of high morbidity due to infection (Table 6) attributable to poor hygiene are thought to be the major factors responsible for the observed growth faltering. These data indicate that observed differences in quality and quantity of milk secreted by undernourished women do not have any impact on infant growth. Thus it would appear that maternal undernutrition does not have any adverse impact on lactation and lactation protects the breast fed infant's growth in the midst of poverty and undernutrition.

Effect Of Lactation On Fertility

Viviparity and lactation are considered as the most important of evolutionary processes resulting in reduction in reproductive wastage and ensuring species survival. The growing foetus in utero is assured of adequate nutrition and protection from external environmental hazards. After birth the nutritional requirements during early infancy are fully met by lactation. Presence of the mother offers some protection against adverse environmental factors during infancy. Having assured better survival of the species, nature also provided a method of fertility control for safeguarding against overpopulation and its attendant hazards. Placental steroids prevent ovulation during pregnancy. Suckling-induced endocrine changes result in relative infertility during lactation. Over millenia, breast feeding has been the major determinant of infant growth, health and survival, and the contraceptive effect of lactation has been the principal regulator of human fertility[4,40].

During the early weeks of lactation, plasma prolactin levels are high, and suckling induces further elevation of these levels. The presence of high prolactin levels are associated with: (a) altered pituitary responsiveness to GnRH, (b) loss of pulsatile LH secretion, (c) inhibition of ovarian follicular development and estradiol production in spite of normal FSH levels, and (d) enhancement of negative feedback and the abolition of a positive feedback mechanism between estrogens and FSH. It is still not known which of these changes in the hypothalamic-pituitary-ovarian axis is the primary alteration induced by prolactin, that, in turn, triggers other alterations. It is also possible that prolactin per se might induce many or all of these alterations in the hypothalamic-pituitary-ovarian axis which result in anovulation, amenorrhea and infertility[23].

Effect of duration of lactation: The duration of lactation shows wide variation among women in different countries and between different communities within the same country[4,5]. However, studies from all over the world have shown that in spite of variations, the duration of lactation is a very important

determinant of duration of lactational amenorrhea. Conception rate during lactational amenorrhea, irrespective of its duration, is less than 10 percent (Table 7)[4].

Studies from the developed countries have shown that with prolonged lactation, prolactin levels are considerably diminished and suckling-induced prolactin peaks become progressively smaller in magnitude[23]. Comparable studies from developing countries indicated a similar trend, although the elevated prolactin levels persisted for a much longer period[23,40].

The reasons for reduction in plasma prolactin levels, despite continued lactation, are not clear. In the developed countries, women tend to introduce supplements to breast fed infants between six weeks and six months of age. Ample data exist to indicate that introduction of supplements results in reduction in the duration of suckling and number of suckling episodes, and this in turn is associated with a reduction in prolactin levels[23] (Table 8). It was therefore assumed that a reduction in the suckling stimulus might be the major factor responsible for the decline in prolactin levels with increasing duration of lactation.

Data from the developing countries indicate that even in women who solely breast feed their infants 12-14 times a day on demand, the plasma prolactin levels declined with increasing duration of lactation[22,23,44]. Obviously, under these circumstances the reduction in plasma prolactin levels could not be attributed to a reduction in the suckling stimulus. It is not known whether the fall in the plasma prolactin levels is due to a decreasing responsiveness of the neural pathway or an altered response of the hypothalamus to the suckling stimulus. Even with the low prolactin levels, lactation continues. However, with a fall in the prolactin level, there is an increasing plasma concentration of IH and also the return of pulsatile IH activity. With the return of normal pituitary activity, ovarian follicular development, estradiol production and resumption of ovulation occur rapidly in spite of continued lactation.

Studies from India have shown that prolonged lactation beyond 18 months does not offer any protection against pregnancy[31]. The resumption of menstruation and ovulation inevitably occur despite continued lactation, and no less than 30 percent of all pregnancies occur in lactating women in these communities[31].

Effect of introduction of supplements to breast fed infants: Studies from developed and developing countries have indicated that the introduction of supplements to breast fed infants is associated with a rapid return of menstru-

ation among lactating women[4,34,40]. Longitudinal studies on the hormonal profiles of lactating women, carried out at Edinburgh, have demonstrated that the introduction of supplements to breast fed infants results in a reduction in the duration of suckling or the number of feeds. This, in turn, causes a decline in prolactin levels, the reversal of prolactin-induced changes in the endocrine profile, and the rapid return of ovulation and menstruation[23].

In developing countries, women breast feed infants on demand, and the mean number of suckling episodes vary between 10-16 per day. There had been speculations whether introduction of supplements to breast fed infants in these communities would also result in a decline in prolactin levels. Studies undertaken in India and Africa have indicated that even among these women introduction of supplements to breast fed infants is associated with some fall in plasma prolactin levels[22,23,44]. These data suggest that it is the magnitude of reduction in suckling episodes or duration, rather than the absolute number of feeds, that determines the fall in plasma prolactin and the return of menstruation and fertility following introduction of supplements to breast fed infants.

There are wide variations in the time and type of supplements introduced to breast fed infants between different countries. Until recently it was assumed that the introduction of any supplements at any time would probably result in a fall in plasma prolactin and a rapid return of fertility. Studies from Africa, however, indicated that in communities where chewed casava was given to the neonates during the immediate postpartum period, introduction of supplements did not have any effect on maternal plasma prolactin levels during different periods of lactation, nor did it shorten the duration of lactational amenorrhea and infertility[45]. It is therefore possible that the introduction of supplements begun in the immediate postpartum period, before establishment of the hormonal profile governing lactation and fertility during lactation, may not have any impact either on prolactin levels, lactation per se or the return of fertility during lactation.

Data from some of the studies from India suggest that among women who introduced supplements earlier than 12 weeks and continued to breast feed their infants 10-12 times a day on demand, the return of fertility and menstruation occured four to six months after introduction of the supplements (Table 9)[34]. The plasma prolactin levels, though lower than those of women whose infants were solely breast fed, were still high enough to cause endocrine changes associated with lactational infertility[44]. The introduction of supplements between six to nine months was followed by a reduction in the number of feeds and/or a reduction in the duration of suckling. Plasma prolactin levels declined, and the return of menstruation occurred within four to six weeks. If the introduction of supplements was delayed beyond one year,

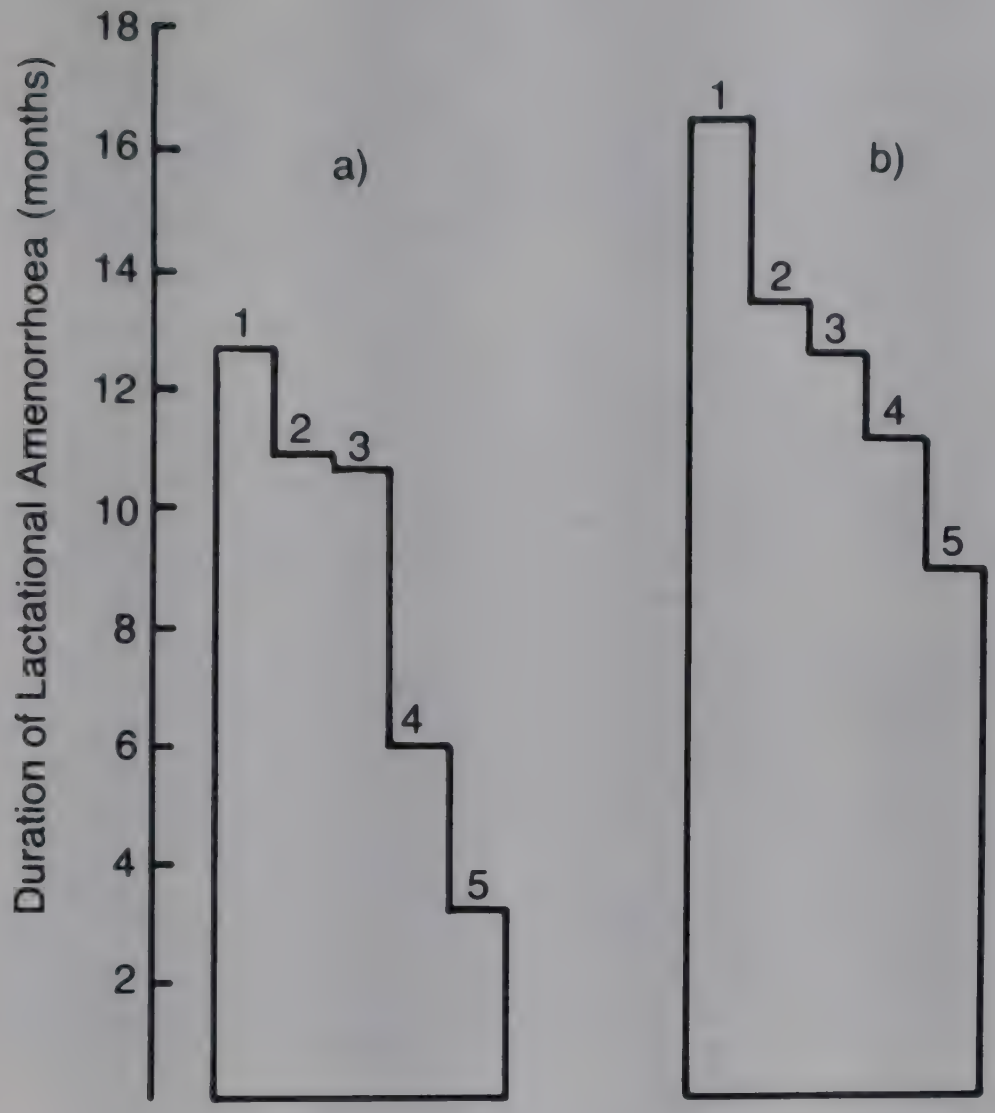
plasma prolactin levels declined sharply in spite of continued unsupplemented lactation[44]. Once the decline in plasma prolactin levels has occurred, fertility and menstruation return rapidly. Thus, it would appear that the timing and type of supplements introduced influence plasma prolactin levels and the return of fertility during lactation. Further investigations need to be undertaken to define the physiological basis of these differences and the possible impact of different types of weaning practices on fertility in different communities.

Some of the studies undertaken in India also showed that early introduction of supplements resulted in shorter duration of lactation (Table 9)[34]. Obviously this is undesirable, especially among the poorer segments of the population in developing countries where infant nutritional status depends upon prolonged lactation. It is possible that the introduction of supplements and consequent reduction of plasma prolactin levels results in resumption of ovarian activity and elevation in plasma estradiol levels. It is well known that estrogens inhibit milk secretion. Thus, reduction in the total duration of lactation might, at least in part, be attributable to the fall in plasma prolactin levels and the consequent elevation of estrogen levels.

Effect of maternal nutritional status on lactational infertility: Available data from developed and developing countries indicate that lactational amenorrhea is shorter among well nourished women from developed countries and among socio-economically better off segments of the population in developing countries. However, it has been suggested that the shorter duration of lactational amenorrhea might, at least in part, be attributable to confounding variables such as the earlier introduction of supplements and schedule feeding among well nourished women, rather than a better nutritional status per se. In the last decade, two studies have attempted to define the role of maternal nutritional status on duration of lactational amenorrhea. One of these studies was undertaken among urban low income group women with similar breast feeding practices who did not receive any health and/or nutritional intervention[32]. The mean duration of lactation and lactational amenorrhea were significantly shorter in women whose body weights were over 55 kg (Table 10). This difference in duration of lactational amenorrhea persisted even after eliminating the effect of duration of lactation (Table 11, Fig. 1), suggesting the possibility that maternal nutritional status might modify return of menstruation in lactating women[32].

Evidence that maternal dietary intake modifies duration of amenorrhea came from studies in Gambia[22]. In Gambian women, prolactin levels were higher and the duration of lactational amenorrhea was longer during the rainy season, when calorie intakes were lower. Food supplementation to lactating mothers resulted in a fall in prolactin levels and a reduction in the duration of lactational amenorrhea. Average birth intervals were also shorter in women receiving supplements.

Fig. 1. Effect of Body Weight (kg) on Duration of Lactational Amenorrhoea (months) in Indian Women from Low Income Groups.



a) Women lactating for 13-18 months
b) Women lactating for 19-24 months
Body weights (kg) were 1, < 40; 2, 40-44; 3, 45-49; 4, 50-54; 5, ⩾ 55.

Obviously, under conditions of food scarcity and consequent undernutrition, it is essential to ensure a longer inter-birth interval so that the advent of the next pregnancy does not cause further deterioration in both maternal and infant nutritional status. Data from Gambia suggest that prolactin levels increase in response to a lower dietary intake. It has been suggested that higher prolactin production was an adaptive process by which milk output was maintained in spite of maternal undernutrition. It is also possible that poor milk production in undernourished women might lead to more vigorous and/or longer suckling and consequently, a higher prolactin secretion. Whatever may be the exact mechanism, higher prolactin levels among poorly nourished women might result in lactational amenorrhea lasting longer in undernourished communities.

Data from the Indian study suggest that for any given duration of lactation, lactational amenorrhea lasts longer in women who have lower body weights. Available information on nutrition-fertility interactions suggest that under two circumstances (at menarche and at the time of re-establishment of menstruation in lactating women) maternal nutritional status might modify menstrual cycles. The exact mechanism by which undernutrition delays the onset of mestruation is not understood. Presumably, the effect is mediated through alterations in the hypothalamic-pituitary-ovarian axis. Pharmacokinetic studies in experimental animals and in women have shown that, following the administration of exogenous steroids, plasma levels were lower and urinary excretion was higher in the undernourished group. A similar mechanism might operate with respect to endogenous steroids. It is possible that women with higher body weights have higher sustained levels in plasma estradiol for the same amount of endogenously produced estrogens. This would result in an accelerated re-establishment of the normal pituitary-axis relationship and a consequent faster return of ovulation and menstruation[41]. This hypothesis needs verification.

Undernutrition is common among women belonging to low income groups in developing countries. Several attempts are being made to improve the maternal nutritional status of this vulnerable segment of the population. Studies from Gambia and elsewhere suggest that improvement in maternal nutritional status might result in a faster return of menstruation and fertility in lactating women. This, in turn, will shorten the interpregnancy interval in the absence of widespread use of contraceptives. Rapid advent of the next pregnancy is likely to nullify the benefits of food supplements. It is, therefore, essential to ensure that efforts to improve maternal nutrition are accompanied by efforts to increase contraceptive use; integrating contraceptive care with food delivery systems might incidentally lead to increased acceptance of contraception.

Effects of contraception on lactation: What is the appropriate time for introduction of contraception in lactating women and what is the appropriate contraceptive method? Available data suggest that less than 10 percent of the women conceive during lactational amenorrhoea. Introduction of contraceptive measures can therefore be postponed until return of menstruation especially in countries with liberalised abortion laws. IUD, conventional contraceptives and tubal ligation do not have any adverse effect on lactation. In the past when combination pills with more than 50 μg estrogen were in use, several studies have indicated that OCs inhibited lactation. The currently used low dosage combination pills which are begun after six months of lactation apparently do not have any adverse effect on lactation [39]. The progestrogen contraceptives, oral, injectable or implant, also do not have any effect on lactation [39]. None of the contraceptives has any adverse effect on growth of breast fed infants. However, all these hormonal contraceptives shorten the duration of lactational amenorrhoea (Table 12) [27]. The mechanism involved in this situation wherein an exogenous steroid exerts its effect on return of menstruation, but not on lactation, need to be explored.

It is now well established that small amounts of steroidal contraceptives get excreted in milk, though the exact amount and chemical nature are not known[39]. There are case reports documenting association between maternal OC use and transient enlargement of breast in breast fed infants. However, so far there had not been any reports of any health hazards in breast fed infants attributable to OC use in lactating women. The association of DES administration during pregnancy with vaginal carcinoma in girls born to these mothers, came to light nearly two decades after therapy. In view of such an eventuality it may be wiser to err on the side of caution and avoid using steroidal contraceptives in lactating women.

Maternal nutritional status and contraception: Until the mid '60s contraceptive use was not widespread in developing countries. However in recent years there has been a marked increase in contraceptive use even among the poorer and less educated segments of population in developing countries among whom undernutrition is common. Data from studies in the '60s and '70s indicated that provision of contraceptives can be one of the most effective non-nutritional intervention for improvement of maternal nutritional status. (Table 13). It therefore became imperative that information on nutrition contraception interactions are obtained, so that appropriate contraceptive care could be provided to undernourished women.

Studies on bioavailability of hormonal contraceptives have shown that though undernutrition does modify the bioavailability of hormonal contraceptives, the dosage in the currently used formulations are sufficient to ensure contraceptive efficacy[24].

Studies undertaken in India and other developing countries indicate that the metabolic side effects of hormonal contraceptives are not in any way worsened by maternal undernutrition[8]. Though anaemia, iron and folate deficiency are widespread among undernourished women, use of low dose combination pills or injectable contraceptives did not aggravate the existing deficiency[26] (Table 14). Similarly biochemical and clinical signs of vitamin B complex deficiency which are widespread in undernourished women did not show any further deterioration with oral contraceptive use. In spite of the fact that intrauterine devices increase menstrual blood loss, there was no increase in prevalence of anaemia, even among long term IUD users[26]. Among the low income group population, tubectomy, hormonal contraceptives and IUD do not have any effect on body weight of the user[28]. These data suggest that safety and efficacy of contraceptives are not adversely affected by undernutrition and that maternal undernutrition does not get aggravated by contraceptive use.

Summary

The adverse effect of undernutrition on lactation is not striking; presumably nature ensures that despite her undernutrition, the lactating mother is able to secrete about 400-600 ml milk daily, though this amount falls considerably short of that secreted by well-fed mothers. Obviously this can only be achieved at the cost of maternal nutrition. Lactation does have an adverse effect on maternal nutrition. Lactation provides some protection against pregnancy and this effect is more marked in undernourished women. Early advent of the next pregnancy has a deleterious effect on maternal nutrition. Initiation of contraception at the appropriate time will prevent this. Contraceptives should, however, be chosen with care so that they have no effect on lactation, maternal or infant nutrition.

Efforts to improve nutritional status and early introduction of supplements to infants are likely to result in faster return of fertility in lactating women. This, clearly, is not to be used as a convenient argument against vigorous efforts at improving and sustaining maternal nutrition. It is essential that nutrition education measures aimed at improvement of maternal and infant nutritional status should be coupled with educational measures to promote contraceptive acceptance. An integrated programme of health, nutrition and contraceptive care to lactating women and their infants is likely to pay better dividends both to the family and to the nation.

This above account should not lead to the unintended impression that maternal undernutrition will not deleteriously affect lactation performance to any significant extent. Studies done in the '50s at the National Institute of

Nutrition (then, the Nutrition Research Laboratories, Coonoor) showed that increased calorie intake did result in increased milk output; that vitamin supplementation did bring about improvement in its quality. Recent studies by the Nutrition Foundation of India point to the distinctly poorer lactation performance of poor women of the Calcutta region as compared to that of poor women of the Bombay region; the former being more stunted and of poorer body build.

Table 1

Dietary Intakes during Lactation

Group	No.	Protein (g)	Calories (Kcal)	Iron (mg)	Thiamin (mg)	Ribo-flavin (mg)	Body weight (kg)
1. Lactating women	38	26.3 ± 1.93	1,110 ± 73.4	12.0 ± 0.809	0.53 ± 0.047	0.39 ± 0.035	42.9 ± 1.31
2. Non-pregnant non-lactating women	34	30.2 ± 2.68	1,125 ± 73.9	11.4 ± 0.058	0.53 ± 0.058	0.40 ± 0.035	44.4 ± 1.1

Values are Mean ± S.E.
't' test: there were no significant differences between groups 1 and 2 in any of the parameters.

Table 2

Changes in Anthropometric Indices during Lactation

No.	Duration of lactation	Height (cm)	Weight (kg)	Mid-arm circumference (cm)	Skinfold thickness at triceps (mm)
a. 1025	Non-pregnant non-lactating	150.1 ± 5.20	44.4 ± 8.16	23.3 ± 2.59	14.1 ± 5.12
b. 860	< 6 months	150.2 ± 5.17	44.4 ± 7.25	23.1 ± 2.62	13.2 ± 5.03
c. 609	7-12 months	149.4 ± 7.12	42.9 ± 6.72	22.3 ± 2.63	12.4 ± 6.59
d. 280	> 12 months mainly breast fed	150.2 ± 6.25	42.1 ± 6.95	21.8 ± 2.52	11.9 ± 6.21
e. 384	> 12 months mainly on supp-lementary food	150.1 ± 5.71	44.3 ± 6.13	22.8 ± 2.07	13.0 ± 6.15

Values are Mean ± S.D.

't' test

a vs. b	*NS*	*NS*	*NS*	*P <0.001*
b vs. c	*NS*	*P <0.001*	*P < 0.001*	*P < 0.001*
c vs. d	*NS*	*NS*	*P <0.01*	*P <0.01*
d vs. e	*NS*	*P <0.001*	*P < 0.001*	*P < 0.001*

Table 3

Haemoglobin Levels in Lactating Women

Duration of lactation	Haemoglobin (g/dl)
	Women attending general out-patient department
a. Non-pregnant, non-lactating women	11.7 ± 1.92 (981)
b. Lactation ≤ 6 months	12.2 ± 1.82 (760)
c. Lactation 7-12 months	11.9 ± 1.76 (540)
d. Lactation > 12 months	11.6 ± 2.16 (452)

Values are Mean ± S.D.
Figures in parentheses indicate number of observations
't' test

a vs. b	*P < 0.001*
b vs. c	*P < 0.01*
c vs. d	*P < 0.02*
d vs. a	*NS*
b vs. d	*P < 0.001*

Table 4

Longitudinal Studies on Growth of Breast Fed Infants in Rural Communities

	Age (months)						
	At birth	1	2	3	4	5	6
Weight (g)	2632 ± 461 (25)	3492 ± 491 (25)	4269 ± 488 (25)	4961 ± 524 (25)	5493 ± 626 (25)	5976 ± 721 (25)	6436 ± 842 (25)
Increment in weight(g)		860	777	692	483	483	460

Semilongitudinal data on growth of infants

	Age (months)						
	At birth	1	2	3	4	5	6
Weight (g)	2608 ± 471 (428)	3490 ± 591 (320)	4250 ± 649 (306)	4975 ± 701 (280)	5537 ± 794 (262)	6035 ± 842 (248)	6458 ± 954 (232)
	0-1	0-2	0-3	0-4	0-5	0-6	
Increment in weight from birth weight(g)	942 ± 186 (320)	1667 ± 567 (306)	2346 ± 667 (280)	2892 ± 839 (262)	3312 ± 962 (248)	3832 ± 962 (282)	
	0-1	1-2	2-3	3-4	4-5	5-6	
Increment in weight between two months(g)	942 ± 186 (320)	764 ± 141 (268)	710 ± 152 (241)	528 ± 198 (215)	481 ± 201 (204)	408 ± 221 (196)	

Figures in brackets indicate sample size

Table 5

Growth of Urban Breast Fed Infants in Relation to Breast Feeding Practices

Age (months)	Body weight (kg), Mean ± S.D. Solely breast fed	No. of infants	Partially breast fed	No. of infants
1	3.32 ± 0.701	259	3.20 ± 0.864	28
2	4.19 ± 0.754	229	4.23 ± 0.924	28
3	4.96 ± 0.912	202	5.01 ± 0.932	58
4	5.50 ± 0.821	177	5.49 ± 0.992	74
5	5.91 ± 1.071	118	5.98 ± 0.906	54
6	6.30 ± 0.898	102	6.40 ± 0.901	80
7	6.60 ± 0.972	69	6.74 ± 1.025	48
8	6.86 ± 1.045	44	7.10 ± 1.070	41
9	7.10 ± 0.897	44	7.34 ± 1.092	38
10	7.22 ± 0.798	26	7.41 ± 0.992	31
11	7.38 ± 0.869	25	7.64 ± 1.061	38
12	7.44 ± 1.203	40	7.81 ± 1.291	67
13-18	7.52 ± 1.471	29	7.92 ± 1.465	96
19-24	8.10 ± 1.541	16	8.46 ± 1.465	128

Table 6

Morbidity Due to Infection in Urban Infants in Relation to Breast Feeding Practices

	Age (months)							
	0-3		4-6		7-9		10-12	
	SBF	PBF	SBF	PBF	SBF	PBF	SBF	PBF
Total no. of infants	121	14	84	46	78	62	46	92
Infants with one episode of illness (%)	18.2	28.4	20.4	28.6	20.6	24.2	26.8	26.2
Infants with more than one episode of illness (%)	2.8	7.1	1.4	4.2	2.1	3.1	3.1	2.4

* *(SBF) solely breast fed; (PBF) partially breast fed*

Table 7

Effect of Lactation on Postpartum Amenorrhea and Conception Rate

Geographical area (year in survey)	Type of population	Mean duration of lactation (months)	Mean duration of lactational amenorrhea (months)	Postpartum amenorrhea in non-lactating women (months)	Conception during lactational amenorrhea (%)
Rwanda (1969)	Rural	18.0	12.0	–	8.0
Bangladesh (1974)	Rural	24.0	18.9	2.0	6.8
Taiwan (1970)	Urban	14.0	9.3	3.5	–
Taiwan (1970)	Rural	17.7	11.4	–	–
Chile (1972)	Urban	3.7	3.8	1.6	7.1
India (1979)	Urban	15.2	10.9	3.2	8.8
India (1981)	Urban	19.8	11.0	4.6	7.4

Table 8

Prolactin Levels (ng/ml) in Relation to Breast Feeding Practices

	Duration of lactation (months)							
	< 3		3-6		> 6		Total	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Suppl.	47.4	8.23	51.5	7.67	43.0	5.73	46.1	3.91
	(6)		(5)		(11)		(22)	
Nonsuppl.	67.6	12.84	63.5	8.37	79.5	18.63	67.7	6.59
	(9)		(19)		(7)		(35)	

* *Mean values for nonsupplemented (nonsuppl.) group were significantly different from those for the supplemented (suppl.) group ($p<0.05$). Numbers in parentheses are the number of women tested.*

Table 9

The Effect of the Introduction of Supplements to the Infant on Duration of Lactation, Lactational Amenorrhea, and Interpregnancy Interval

Age in months at introduction of supplements*	Duration of unsupplemented lactation**	Duration of lactational amenorrhea**	Duration of lactation**	Duration of interpregnancy interval
0-3 (133)	2.3 ± 0.1	7.6 ± 0.6	15.1 ± 0.9	19.5 ± 1.2
4-6 (268)	5.3 ± 0.1	9.3 ± 0.5	17.9 ± 0.6	21.4 ± 0.9
7-9 (153)	8.0 ± 0.1	10.8 ± 0.7	20.2 ± 0.8	23.1 ± 1.4
10-12 (239)	11.8 ± 0.5	13.1 ± 0.5	23.3 ± 0.5	26.0 ± 0.9
13-18 (34)	17.2 ± 0.3	17.3 ± 1.7	25.3 ± 1.1	27.9 ± 2.1
19-24 (32)	24.0 ± 0.0	18.2 ± 2.0	33.9 ± 1.2	34.7 ± 2.5
> 25 (26)	33.2 ± 1.3	20.0 ± 2.9	42.9 ± 2.6	42.7 ± 3.7

* *Figures in parentheses indicate the number of postpartum periods in which lactation was successfully established.*

** *All values are in months (Mean* ± SE)

Table 10

Effect of Body Weight on Duration of Lactation and Lactational Amenorrhea in Indian Women (2042 lactational periods studied)

Body weight (kg)	Mean duration of unsupplemented lactation (months)	Mean duration of lactation (months)	Mean duration of lactational amenorrhea (months)
< 40	9.2	20.9	13.2
40-44	8.9	19.8	11.4
45-49	8.6	20.1	10.2
50-54	8.4	19.8	9.3
⩾ 55	7.6	16.6	7.5

Body weight vs. duration of lactation:
Duration of lactation = 45.80 – 0.0314 × body weight
(r – 0.0566 not significant).
Body weight vs. duration of lactational amenorrhea:
Duration of lactational amenorrhea = 46.78 – 0.1824 × body weight
(r –0.7251, $p < 0.001$).
Partial correlation between:
Lactation and lactational amenorrhea = 0.6914, $p < 0.001$
(keeping body weight constant)
Body weight and lactation =–0.0250, NS
(keeping lactational amenorrhea constant)
Body weight and lactational amenorrhea = –0.8139, $p < 0.001$
(keeping duration of lactation constant)

Table 11

Effect of Body Weight on Duration of Lactational Amenorrhoea in a Group of Indian Women from a Low Income Group Matched for Duration of Lactation

	Mean duration of lactation (months)		Mean duration of lactational amenorrhoea (months)	
Body weight (kg)	Mean	S.D.	Mean	S.D.
< 40 (276)	21.3	10.61	13.1	11.74
40-44 (356)	22.5	10.32	12.0	8.23
45-49 (297)	20.8	10.76	10.7	9.36
50-54 (209)	20.7	10.58	9.3	10.13
⩾ 55 (222)	20.7	8.53	8.2	7.82

Figures in brackets indicate sample size.

Table 12

Duration of Lactation and Lactational Amenorrhea in Women using Hormonal Contraceptives or IUD

Group	Number	Previous lactation period		Present lactation period	
		Duration of lactation (months)	Duration of lactational amenorrhea (months)	Duration of lactation (months)	Duration of lactational amenorrhea (months)
Control	1917	20 ± 9.4	11 ± 5.0	20 ± 9.6	11 ± 5.0
Inj. DMPA,150 mg 3 monthly	22	21 ± 10.4	11 ± 5.6	22 ± 11.8	6 ± 3.2***
Inj. Net-en, 20 mg monthly	51	20 ± 10.5	12 ± 6.0	19 ± 10.9	8 ± 4.1**
Combination pill (150 μg of d-norgestrel and 50 μg ethenyl estradiol)	52	19 ± 10.5	11 ± 5.8	21 ± 10.8	9 ± 4.1**
Combination pill (150 μg of d-norgestrel and 30 μg ethenyl estradiol)	50	20 ± 11.4	11 ± 5 9	21 ± 11.0	9 ± 4.2
Copper IUD users	68	20 ± 10.8	11 ± 5.8	21 ± 10.8	11 ± 5.6
Tubal ligation	55	21 ± 12.0	11 ± 6.0	22 ± 10.7	12 ± 5.4

*Values are mean ± S.D. 't' test **P<0.01 ***P<0.001*

Table 13

Nutritional Status of OC Users (Cross-sectional Data)

Groups	No. of women	Height (cm)	Weight (kg)	Arm circumference (cm)	Skinfold thickness (mm)	Haemoglobin (g/dl)
[Control group]						
Women seeking contraceptive advice	506	151.4 ± 4.17	44.8 ± 6.17	22.9 ± 2.86	13.9 ± 6.13	12.9 ± 1.43
[OC users]						
3-6	208	151.8 ± 4.23	44.9 ± 6.12	23.2 ± 2.43	14.3 ± 5.21	12.8 ± 1.59
7-12	120	151.2 ± 4.52	44.5 ± 6.52	23.1 ± 2.86	13.9 ± 5.55	12.8 ± 1.64
13-24	30	150.6 ± 5.59	44.9 ± 6.55	23.4 ± 3.04	14.4 ± 5.72	12.7 ± 1.61
25-36	21	150.9 ± 5.97	44.5 ± 6.95	23.3 ± 3.42	14.4 ± 6.02	12.8 ± 1.58

Values are mean±SD

Table 14

Haemoglobin in Contraceptive Users
Haemoglobin levels in IUD and Hormonal Contraceptive Users
Cross-sectional Study

Group	No.	Haemoglobin g/dl	± of women with level below 12 g/dl
a) Contraceptive advice seekers	428	12.7 ± 1.67	29.2
b) Copper IUD wearers			
< 1 year	98	12.7 ± 1.26	30.1
1-3 years	44	12.9 ± 1.29	27.2
Lippe's loop wearers			
< 1 year	75	12.5 ± 1.21	26.3
1-3 years	38	12.7 ± 1.48	23.6
3-10 years	20	12.5 ± 1.72	25.0
c) Oral pill users			
12-18 months	106	12.6 ± 1.37	26.4
d) Injectable progestogens			
DMPA 150 mg 3 months for 12 months	20	12.9 ± 1.86	25.0

Values are mean±S.D.

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Nutritional Deficiency Diseases

S.G. Srikantia

It is widely accepted that the nutritional status of Indian women belonging to the low income groups is unsatisfactory. In traditional households, food is first served to men and children and women usually eat last. These two observations have led to the belief that in the matter of allocation of food within a family, particularly the economically disadvantaged one, the dietary intakes of women are more unsatisfactory than those of men. Even among young children, it is believed that culturally determined behaviour places the female child at a nutritional and health disadvantage, as compared to the male child. While there are many studies in our country which have provided data on the prevalence of nutritional disorders in communities, there have been relatively few which provide information on the magnitude of the problem in the two sexes separately. National survey data, as opposed to data from some isolated micro level studies, indicate that the diets of girls and women are not any more inadequate than those of boys and men and that there is no strong evidence of discrimination against females in the matter of food allocation. There is, however, evidence that prompt health and medical care during acute illness is often denied to the female child as compared to the male. This may indirectly affect nutritional status. In recent years, data on the prevalence of deficiency diseases have been reported separately for the two sexes. These are reviewed here.

Protein-Energy Malnutrition

It has already been pointed out that the growth pattern of girls (and boys) belonging to the poor income groups in our country is different from that of children belonging to the economically better off groups. A large proportion of girls in the low income groups have heights and weights well below 'stan-

dard' values. The extent of growth retardation in a child can be quantified by determining the extent to which its measurements deviate from standards and the quantum of malnutrition in a community can thus be assessed. Using this technique separately for boys and girls, it would be possible to determine sex-related differences, if any, in the magnitude of the problem. Among adults, weight for height is generally used as an indicator of nutritional status and making use of this parameter, the relative prevalence of malnutrition among adult men and women can be computed. Results of such analyses are available through the data collected on a large number of pre-school children and on a limited number of adults. Some of these are discussed here.

Children

Weight for age: When classified according to weight for age status (> 90 percent of standard : normal ; 75-90 percent : mild ; 61-75 percent : moderate and < 60 percent: severe malnutrition), the NNMB has reported that only about 20 percent of rural girls in India are normal and that the rest have varying degrees of malnutrition[11]. What is striking is the consistent observation from data collected over several years, that, compared to boys, a much higher proportion of girls are normal (almost twice as many) and a much lower proportion of girls have severe malnutrition (only half as many) (Table 1). A similar observation has also been made among urban children[14] (Table 2).

In a study done among rural, urban and tribal children in Calcutta and Jabalpur[17] recently, a somewhat different picture has emerged. There were no sex differences among rural children, but among urban children, though the proportion of normals was similar in the two sexes, more girls were found to have severe forms of malnutrition (Table 3). In a small series of children studied in a few villages in interior Uttar Pradesh, no sex differences were found in the distribution of boys and girls according to their weight for age status[17] (Table 4).

In a group of over 6,500 rural children of preschool age, around Hyderabad, more boys were normal (3.8 percent vs. 2.2 percent) while more girls had severe malnutrition (18.2 percent vs. 10.5 percent)[19]. These findings are somewhat similar to that reported for children who attended the Safdarjung Hospital in New Delhi[3]. Of the 7,363 male children and 6,056 female children below the age of five years, the proportion of normal girls was much lower than that of normal boys (23.9 percent vs. 33.7 percent) and the proportion of severely malnourished girls was much higher than among boys (19.5 percent vs. 13.2 percent). This is also similar to what has been reported from two villages in West Bengal — that severe malnutrition is more frequently seen among girls than among boys[23].

The wide variations in actual percentages in the different studies are easily explained – different workers have employed different standards. It is, however, difficult to explain the divergent findings made in the NNMB and the other studies. A criticism which has been levelled against the NNMB analysis is that the 'standards' used were obtained by measuring a sample of children from just one part of the country – Hyderabad. Furthermore, when these standards are compared with the widely used NCHS standards, it is found that differences in weight for age values between boys and girls are of a much higher order in the 'Hyderabad' standards. If the validity of the Hyderabad standard is in question, the conclusion that more girls have normal growth than boys, would be suspect. On the basis of further analyses, Gopalan has suggested that there is "no significant evidence of any bias against any sex"[6] at least on the basis of available growth data from field studies.

The comparison of hospital-based data with community-based data may not be valid, since the hospital sample is likely to be biased on several counts, including the culturally determined practice of male children being brought to the hospital earlier than female children. This would result in a larger proportion of male children with relatively better nutritional status being seen in the hospital sample. There are several studies which suggest that in the matter of medical care, boys receive preferential attention[7]. The sample size in the West Bengal villages is small, while the study at Hyderabad was done a few years before the NNMB studies were initiated.

Whether any or all of these factors can explain the divergent findings is not clear. But what data are available do not permit the claim of any evidence in favour of sex differences in the weight for age status of preschool children.

Height for age: There is, however, agreement regarding the height for age status. In both the NNMB rural studies[11] in the Calcutta-Jabalpur study, and in Uttar Pradesh[17] the proportion of boys and girls who were stunted were essentially similar (Table 5). As in the case of weight for age, the use of different standards is responsible for the variations in actual percentages between the two sets of data.

Clinical forms: Data on the prevalence of the clinical forms of severe malnutrition — kwashiorkor and marasmus — separately for the two sexes are scanty. It has, however, been reported that, while in community studies among children with kwashiorkor from the poor income groups, girls outnumbered boys by four to three, hospital admissions showed a preponderence of boys – 53 to 47[7]. This dichotomy has again been ascribed to the possibility of

boys being brought to the hospital for treatment more readily than girls. No sex differences in mortality rates have been found among the hospitalised children.

Earlier nutrition surveys suggest that between two and three percent of poor rural preschool children develop these severe clinical forms. The more recent NNMB survey data show that prevalence of these forms is less than one percent. Whether the earlier findings with respect to sex differences are still valid needs to be reexamined.

Irrespective of whether or not the prevalence of protein-energy malnutrition of various grades, including the clinical forms, is higher in girls than in boys, the central point to remember is that only 20 percent or less of the rural girls preschool child population has normal weight for age and that only one half has normal height for age. The nutritional and health consequences of this situation are serious, since such children often end up as short statured women with low body weights, which have functional implications.

Children Aged 5-15 Years

Data on the distribution of older boys and girls in the age group five to 15 years according to their growth status appear to be scanty. The limited information available from two studies[17], one in rural Uttar Pradesh and one in rural Haryana. with rather small numbers investigated show that, in both places, a smaller proportion of girls had normal weight for age, as compared to boys[19]. But with respect to the severe grades of malnutrition, there was a difference between the two places. In Haryana the proportion of girls with grade 3 malnutrition was higher than in boys, while in Uttar Pradesh, it was the other way round.

With respect to height, however, in both studies a much higher proportion of girls were normal than were boys; also the proportion of girls with severe stunting was much lower (Table 6). The area covered and the sample size are both too small to permit any firm general conclusions to be drawn. Clearly, there is a need for systematic studies to be undertaken to answer the question whether the growth status of the two sexes are different — a question with considerable sociological and health implications. The large volume of data available with the NNMB should be put into effective use for this purpose. Regional variations which may perhaps exist can be uncovered.

Adults

An anthropometric index which is often used to assess nutritional status of adults is their weight for height. A comparison of the frequency distribution of women and men according to this index can therefore be employed as a measure of the relative nutritional status of the two sexes, in addition to determining the proportion of malnourished women in a community. The NNMB data on heights and weights of large numbers of adult men and women in rural India have been presented as means, and it is therefore not possible to get at the frequency distributions of height and weight status. But utilising these data, deficits in weights and heights,compared to standards, have been calculated for men and women in all the 10 states covered by the NNMB[18]. In several states, the deficit in women has been found to be less than in men by five to 10 percent. In no state was the deficit in women larger than that observed in men (Table 7). This trend was present not only in data pooled for the 1975-1979 period, but also in data for the year 1980. The limitation in these calculations needs to be recognised. The weight for height was calculated on the mean values of heights and weights of the whole group, and not on the basis of individual values. That this may not have been a serious limitation in the conclusion drawn, is suggested by the observation made in another study involving two separate rural areas – one in Haryana and the other in Uttar Pradesh[17]. Making use of data from individuals, it was observed in both places that the frequency distributions of weight for height status of men and women were different (Table 8). A considerably higher proportion of women had values above 90 percent of standard as compared to men, though the actual percentage values were different in the two areas. The proportion of women who had values below 70 percent of standard, was lower among women than among men.

A fallacy in the use of weight for height as an index of nutritional status relates to actual height. If the degree of stunting among women is of greater magnitude than among men it can be argued that the weight for height index would mask the poorer nutritional status of women. But all data available so far on preschool and school children as also of adult women, show that there are either no differences between sexes with respect to extent of stunting or where there is a difference, there is less stunting among girls. This implies that the better weight for height status of Indian rural women is a genuine one, not vitiated by considerations of relatively greater shortness.

Absolute heights and weights of women, however, cannot be ignored, since they have been shown to have implications for reproductive performance. Women with heights below 145 cm and women with pre-pregnant weights below 38 kg are more likely to deliver babies with low birth weights, with attendant risks of increased infant mortality and morbidity. Computations from the NNMB data[5] show that in the 10 states studied, between 20 and

35 percent of women in their active reproductive age (20-35 years) have weights less than 38 kg, and between 12 and 25 percent of women are shorter than 145 cm. The real magnitude of poor nutritional status of our poor rural women can be judged from the fact that less than one percent of American women belong to these height and weight categories.

The functional implications of growth failure during infancy and early childhood have been well documented. The disadvantages of small body size during adulthood have also been recognised. The findings that only 20 percent of female children have normal weight for age during preschool age and that almost one half have stunting, that the same is true of girls of school age and that substantial numbers of adult women have heights and weights below what are considered as critical for reproductive performance, highlight the problem of protein-energy malnutrition among Indian women.

Anaemia

Nutritional anaemia is a major health problem in our country and iron deficiency is the most common cause, with folate deficiency acting as an additional contributory factor, particularly during pregnancy. In some places hookworm infestation also adds to the problem.

There is considerable information on the mean haemoglobin levels of various age groups and physiological groups in our country, particularly from hospital-based samples. While these show that anaemia is widespread among children and adults alike, they do not provide reliable estimates of the proportion of the population which is anaemic. Such information has to come necessarily from community surveys.

One of the earliest large scale studies done to determine the magnitude of the anaemia problem among children in our country is that of the Indian Council of Medical Research, as part of a comprehensive investigation of preschool children, in different parts of the country[8]. About 53 percent of children were found to be anaemic. There was an age differential – a higher proportion of children below the age of three years were anaemic as compared to children between the ages of three and five years (63 percent vs 44 percent). An essentially similar, high prevalence rate has been reported from a more recent collaborative study[22], involving large numbers of rural children in Delhi, Calcutta and Hyderabad (Table 9). 64.8 percent of children in the age group of one to six years had anaemia. An exceptionally high prevalence rate of over 90 percent was found in parts of rural Calcutta. Unfortunately, in neither of these two studies has data been given separately for boys and girls.

However, in another study[21], again reported from Hyderabad where over 500 rural girls and 500 rural boys in the age group of three to five years were investigated for their haemoglobin status, prevalence of anaemia was over 50 percent, there being little difference between the two sexes (51 percent among boys; 54.6 percent among girls). Furthermore, the proportions of boys and girls with the mild, moderate and severe forms, were essentially similar (Table 10).

Baseline prevalence rates of anaemia in different age groups of the two sexes, found in a multicentric study conducted in connection with the fortification of common salt with iron[22], as also those found in a study in several villages around Hyderabad[15], are shown in Tables 9 and 11. Both studies have shown that prevalence rates are high and that, while there are no differences between boys and girls below the age of six years, beyond this age, females always had higher prevalence rates compared to males. The striking finding is that with increasing age, prevalence rates came down in males, while such a reduction did not occur in females. As a result, in the active reproductive age, a substantially higher proportion of women had anaemia. In a recent study done in rural Varanasi[16] among children of schoolgoing age, in the six to 14 year group, prevalence of anaemia between boys and girls was similar (50 percent in boys and 52 percent in girls) and somewhat lower than that reported both in the multicentric study and in Hyderabad. A significant finding in these studies is the fact that even among adult men, anaemia is not uncommon – between 35 percent and 40 percent having low levels of haemoglobin.

Prevalence of anaemia among the urban population seems to be of a much lower magnitude than among the rural communities, if data obtained in Madras is any indication[22] (Table 9). Even here, the higher prevalence rates among women is clearly evident.

It would thus appear that while there are regional variations in the extent of the problem of anaemia among women, at least 50 percent in the rural areas and about 25 percent in the urban areas suffer from this deficiency disease.

Pregnancy has long been known to be a period of nutritional stress and it has been repeatedly shown that as pregnancy advances, levels of haemoglobin progressively fall in a great majority of women. In a very recent study[12], involving several thousand women in several villages in Andhra Pradesh, mean levels of haemoglobin in nonpregnant women and pregnant women during the first, second and third trimesters of pregnancy were 10.8g/dl, 10.4g/dl, 9.7g/dl and 9.4g/dl. Parity has also been found to influence the pre-

valence of anaemia. A larger proportion of women who have had four pregnancies or more have anaemia as compared to those who have had three pregnancies or less. Severe anaemia was found almost thrice as frequently in the former group as compared to the latter[20]. The results of a more recent study have shown that the percentage of pregnant women with two pregnancies or less, who had levels of haemoglobin below 9 g/dl was only 23.8 percent as compared to over 42 percent among pregnant women with three pregnancies or more[13].

A number of physiological functions seem to be affected by anaemia. Immune status, work capacity and work output, cognitive function and mental tasks which call for concentration are among the functions which are compromised. Moderate to severe anaemia during pregnancy is also known to increase the risk of women delivering babies with low birth weight. The importance of widespread anaemia among Indian women has to be viewed in the context of these functional consequences.

Vitamin A Deficiency and Deficiency of B Complex Vitamins

The results of several nutrition surveys done in the past have indicated that next to protein-energy malnutrition and anaemia, clinical signs attributable to deficiencies of Vitamin A and the B Complex group are the most frequently seen. In most studies data for whole communities are presented. In the more recent data published by the NNMB, however, information on the prevalence of deficiency diseases has been reported for the two sexes separately, except for children of preschool age. They have been set out in Tables 12, 13 and 14. Data presented in these tables for the rural population have been calculated from figures reported in the annual reports for 1981 and 1982. The limitations in the interpretation of the data must be pointed out. The urban sample size is small, as is the pooled figure from 10 different states, collected over a five-year period. The rural sample is reasonably large, but this is also the pooled figure for two years, of 10 states. Wide variations are seen, from one year to another and between states.

Data presented in the tables show that about 2.5 percent of preschool children (of both sexes) have Bitot spots in the rural areas and in the urban slums, a much less proportion of urban poor income children show this sign of vitamin A deficiency. Among children of school going age, a higher percentage of children had Bitot spots in all three groups — the rural poor, the urban poor and the slum children. In the rural and the slum children, there was a sex difference — more boys than girls having Bitot spots. This is similar to what has been reported earlier not only from this country but from several

other parts of the world. Such a sex difference was not seen among children of the urban poor.

Bitot spots were seen among the adults only infrequently, there being no differences between men and women. In this age group they are not reliable indicators of Vitamin A deficiency.

Signs of B Complex deficiency — angular stomatitis and glossitis — were seen much more frequently than were Bitot spots. Rural children and urban slum children had similar prevalence rates — 7.1 and 8.0 percent respectively, with children of the "urban poor" (not living in slums) having a considerably lower value — 4.7 percent. Prevalence rates among children of school age were much higher than among children of preschool age, there being no marked sex differences. Again, prevalence rates among the rural poor and urban slums were similar and almost twice as high as among the "urban poor". Adults had much lower prevalence rates than those seen in either the preschool or school age children. Men and women had similar prevalence rates. The absence of differences between males and females with respect to the prevalence of signs of B Complex deficiency is contrary to the general belief that women are at a higher risk of developing deficiency.

Goitre

Endemic goitre continues to be a major nutritional health problem in our country. According to some official estimates, about 145 million people live in the goitre-endemic regions, which stretches across the entire sub-Himalayan belt and includes several districts in the states of Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Bihar, Uttar Pradesh, West Bengal, Sikkim, Assam, Mizoram, Meghalaya, Tripura, Nagaland and Arunachal Pradesh. Forty million of the 145 million people living in these places actually have goitre, giving an overall prevalence rate of 28 percent[4]. During the last two decades several new endemic areas of goitre have been identified in Delhi, Madhya Pradesh, Bihar, Maharashtra, Gujarat and Kerala. Andhra Pradesh and Karnataka also have joined these states in having pockets of goitrous zones. The extent and intensity of the problem have varied widely, from a low three percent to a high 60 percent.

Following the introduction of iodised salt as part of the National Goitre Control Programme of the Government of India, prevalence rates have come down in some areas while in others, it has either remained stationary, or actually increased[4]. Following are some examples.

Himachal Pradesh		
Sirmoor	1959	35.8%
	1980	28.07%
Kangra	1956	41.2%
	1962	32.1%
Punjab		
Gurdaspur	1961	52.3%
	1969	42.3%
Chandigarh	1969	11.2%
	1977	45.9%
Bihar		
Champaran	1960	40.3%
(East and West)	1979	64.5%;57.2%
Uttar Pradesh		
Dehra Dun	1965	39.7%
	1969	16.9%
Bijnore	1960	23.2%
	1969	23.6%

Many of these figures are two decades old. Because of the increases in population over this period even in areas where the prevalence rates have come down, the actual numbers of people with goitre would probably be much higher now than before. The Goitre Control Programme has failed to make much of an impact.

Data on the sex-wise prevalence of goitre, in recent surveys, done in a few villages in Varanasi, Uttar Pradesh, show that prevalence rates in female, in the age groups below five years, five to 15 years, 15 to 25 years and over 25 years, were found to be 19.8 percent, 36.3 percent, 31.4 percent and 20.9 percent[1]. Corresponding rates among men were 17.4 percent, 30.1 percent, 19.4 percent and 8.7 percent, respectively, indicating that during reproductive age, females have considerably higher rates compared to males.

The health implications of the higher prevalence rates among women are far-reaching. Goitre during pregnancy can lead to cretinism and in hyperendemic goitrous areas this can reach three to five percent as has been seen in parts of Uttar Pradesh, where villages are goitrous-flood prone. High as this figure is, it does not reflect the true magnitude of the problem and its implica-

tions. Evidence of impaired thyroid functional status of the new born is seen in as high as 13 percent of neonates[9]. This chemical hypothyroidism can end up in suboptimal mental development.

Fluorosis And Lathyrism

These are not deficiency diseases but are food and water related disorders, endemic to some parts of the country. While fluorosis is due to ingestion of excessive amounts of fluoride, mainly through drinking water which contains large amounts of fluorine, lathyrism is due to the habitual consumption of large quantities of the legume – kesari dal (Lathyrus sativus).

Fluorosis: Fluorosis which affects only the teeth is most often seen in children and is relatively not very serious from the health point of view. In adults, however, the disease affects the skeleton, leading to pain and limitation of movement of the spine and several joints. Skeletal fluorosis is irreversible and crippling. Sometimes neurological manifestations are seen as a result of pressure on peripheral nerves.

Till as late as 1960, it was thought that in only four States did the problem exist – Tamil Nadu, Andhra Pradesh, Uttar Pradesh and Punjab. Since then the list of States where fluorosis exists has grown to include Delhi, Gujarat, Haryana, Karnataka, Madhya Pradesh and Rajasthan[24]. In the mid 1970s a new dimension was added to the problem of fluorosis when it was discovered that in parts of Andhra Pradesh endemic to fluorosis a large number of adolescents and young adults had developed knock-knees (genu valgum), a disease which was not there before[10]. This is now recognised as a new clinical entity of fluorosis, brought on as a result of some changes in soil chemistry following constructions of huge dams to impound water[2]. Genu valgum has also made its appearance in parts of South India which are endemic to fluorosis.

In 28 selected villages in Andhra Pradesh, where over 21,000 subjects were examined, the prevalence of genu valgum was as high as 2.8 percent, with wide variations between villages – from 0.2 percent to 17 percent. A striking feature of both the classical skeletal fluorosis and genu valgum is the marked sex predilection, prevalence among females being only a small fraction of that seen in males. It has been suggested that this may be related to the low amounts of fluoride ingested by women, but it would appear that this cannot be the major explanation.

Lathyrism: Excessive consumption of kesari dal (Lathyrus sativus) has long has been associated with the disease lathyrism. The disease is endemic in parts of Madhya Pradesh, Bihar, Uttar Pradesh and West Bengal where the pulse is staple. Irreversible paralysis of the lower extremities, leading to permanent crippling, characterises the disease. It is the young adult who is most frequently the victim. As in the case of fluorosis, there is a marked difference in the prevalence rate between the two sexes – it being very low among females. The reasons for this difference are unknown.

Table 1

Distribution of Boys and Girls According to Their Weight for Age Status*: Rural NNMB Data

Years of study	Number	Malnutrition			
		Normal	Grade I	Grade II	Grade III
1979					
Girls	1736	19.1	45.6	29.6	5.7
Boys	1977	9.9	40.8	39.2	10.1
1980					
Girls	1968	20.1	57.3	25.6	3.0
Boys	2040	9.6	44.6	39.3	6.5
1981 and 1982					
Girls	2363	20.3	47.4	27.2	5.0
Boys	2676	12.4	41.0	40.7	5.9

* *Using Gomez classification and standards for well-to-do Hyderabad children*
Ref. 11

Table 2

Distribution of Boys and Girls According to Their Weight for Age Status: Urban NNMB Data

	Number	Malnutrition			
		Normal	Grade I	Grade II	Grade III
Boys	555	9.0	39.1	42.5	9.4
Girls	690	18.8	43.0	34.6	5.6

Ref. 14

Table 3

Percent Distribution of Boys and Girls According to Their Weight for Height Status* in Calcutta and Jabalpur

	Rural				Urban			
	Calcutta		Jabalpur		Calcutta		Jabalpur	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
	467	393	267	284	477	393	291	310
Normal	7.9	7.7	5.6	4.6	7.2	8.7	6.9	4.8
Grade IIi Malnut-rition	5.6	7.1	16.4	17.9	5.9	11.3	18.2	24.5

**NCHS Standards*
Ref. 17

Table 4

Distribution of Children of Preschool Age According to Their Weight for Age Status in Uttar Pradesh

		Malnutrition			
	Number	Normal	Grade I	Grade II	Grade III
Boys	95	3.2	41.0	41.1	14.7
Girls	105	5.7	27.6	49.5	17.2

Ref. 17

Table 5

Percent Distribution of Boys and Girls According to Their Height for Age Status: Stunting

	Number	Rural NNMB % stunted
Girls	9058	44.1
Boys	9880	44.8

Continued overleaf

Table 5 contd.

Calcutta and Jabalpur

		Rural		Urban	
		Calcutta	Jabalpur	Calcutta	Jabalpur
Normal and mild stunting	Girls	45.6	36.4	37.9	41.1
	Boys	49.1	36.7	32.5	45.9
Moderate and severe stunting	Girls	54.4	63.6	62.1	58.9
	Boys	51.9	63.3	67.5	54.1

Ref. 11 and 17

Table 6

Distribution of Children According to Weight for Age and Height for Age Status 5-15 years, in Haryana and U.P.

	Weight for age			
	Haryana		Uttar Pradesh	
	Boys (118)	Girls (205)	Boys (204)	Girls (117)
Normal	11.0	6.3	10.8	3.4
Grade I	26.3	30.2	31.4	21.4
Grade II	39.8	49.3	39.2	47.9
Grade III	22.9	14.2	17.6	27.3
	Height for age			
	Boys (216)	Girls (205)	Boys (177)	Girls (149)
Normal	42.1	58.0	35.6	51.0
Mild/moderate stunting	50.5	38.0	52.5	49.9
Severe stunting	7.4	4.0	11.3	8.1

Figures in brackets indicate sample size.
Ref. 17

Table 7

Body Size of Adult Males and Females in Rural India Aged 25 to 29 (Percentage ofStandard): NNMB Data

State	1975-1979		1980	
	Males	Females	Males	Females
Kerala	75-79	85-89	80-84	85-89
Madhya Pradesh	80-84	85-89		
West Bengal	75-79	80-84	75-79	80-84
Orissa	80-84	80-84	80-84	80-84
Maharashtra	75-79	80-84		
Uttar Pradesh	80-84	85-89	75-79	80-84
Andhra Pradesh	75-79	80-84	80-84	80-84
Gujarat	75-79	85	75-79	80-84
Tamil Nadu	75-79	80-84	80-84	85-89
Karnataka	80	80-84	75-79	80-84

Ref. 18

Table 8

Proportion of Men and Women with Different Grades of Malnutrition in Haryana and U.P.

	Haryana		Uttar Pradesh	
	Men 352	Women 374	Men 247	Women 193
Weight		Weight as % of standard		
> 90% of standard	21.6	35.8	1.6	21.8
90 – 81	35.5	37.2	32.0	42.5
80 – 71	31.8	19.5	55.5	29.0
⩽ 70	11.1	7.5	10.9	6.7
	Height as % of standard			
Height				
> 90% of standard	23.4	39.2		
90 – 81	35.8	33.8		
80 – 71	31.1	20.3		
⩽ 70	9.7	6.7		

Table 9

Percent Prevalence of Anaemia among Boys and Girls in Different Age Groups

Location	Type of Sample	1-6 years	6-14 years		14-25 years		25-44 years		≥ 45 years
		Boys+Girls	Boys	Girls	Boys	Girls	Men	Women	Men+Women
Hyderabad and Delhi	Rural	64.8 (526)	57.7 (568)	65.9 (459)	44.4 (302)	67.1 (295)	34.1 (425)	68.9 (335)	48.8 (637)
Calcutta	Rural	92.8 (400)	92.9 (571)	97.1 (561)	90.3 (350)	96.7 (338)	80.3 (350)	96.9 (426)	90.1 (393)
Madras	Urban	22.1 (212)	11.6 (297)	15.0 (379)	9.3 (118)	20.8 (255)	3.5 (141)	26.0 (388)	18.6 (215)

Ref. 22

Table 10

Prevalence of Anaemia in Preschool Children Aged 3-5 Years of Rural Hyderabad

		Anaemia % prevalence		
	N	Severe (< 8g/dl)	Mild + Moderate (8-11 g/dl)	Total
Males	522	13.9	37.8	51.7
Females	504	16.1	36.5	54.6

Ref. 21

Table 11

Percent Prevalence of Anaemia in Rural Areas around Hyderabad

Age group (years)	Females	Males
1 – 6	78.4 (347)	74.2 (449)
6 – 14	69.7 (684)	63.7 (830)
⩾ 15	67.4 (1219)	42.0 (1240)

Ref. 15

Table 12

Percent Prevalence of Deficiency Signs among Children of Preschool Age in Rural Areas (Pooled for Boys and Girls)

Location	Number	Bitot spots	Signs of B Complex deficiency
Rural	4717	2.67	7.1
Urban low income	915	0.60	4.7
Urban slums	1285	2.90	8.0

NNMB Rural: 1981 and 1982 pooled
NNMB Urban : 1975-1979

Table 13

Percent Prevalence of Deficiency Signs among Children of School Age

Location	Number	Bitot spots	Signs of B Complex deficiency
Rural			
Boys	3950	5.9	14.1
Girls	3400	3.0	11.3
Urban low income			
Boys	708	2.3	7.9
Girls	690	2.4	4.2
Urban slums			
Boys	869	4.6	15.3
Girls	899	3.3	13.9

NNMB Rural: 1981 and 1982 pooled
NNMB Urban: 1975-1979

Table 14

Percent Prevalence of Deficiency Diseases among Adult Men and Women

Location	Number	Bitot spots	Signs of B Complex deficiency
Rural			
Men	5163	0.8	2.94
Women	5705	0.8	2.50
Urban low income			
Men	1172	0.4	2.7
Women	1544	0.4	3.6
Urban slums			
Men	1402	1.4	5.4
Women	1695	0.9	5.8

NNMB Rural: 1981 and 1982 pooled
NNMB Urban: 1975-1979

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Women And The Health System

Saramma Thomas Mathai

This chapter seeks to examine the current health status of women in India and the present situation regarding utilisation of health services by women as reflected in several available reports and documents. The health status of our women may be expected to reflect the impact which our developmental programmes, and more importantly, our health services have had on our population in general and our women in particular over the last few decades. It is hoped that the data presented here will not only serve to take stock of our achievements but also to indicate the enormity of the tasks that await our health systems and the directions in which it needs to be strengthened in future.

This chapter is divided into six sections. We begin with the section on sex differentials in mortality and life expectancy which should serve to highlight the disadvantage with which Indian women start life and continue to be with, as compared to Indian men. The second section deals with maternal mortality, morbidity, nutritional status and fertility. The third section is devoted to a discussion on adolescent girls and health. The fourth deals with the present state of knowledge, attitude and practices of women with respect to health and disease and use of health services. The fifth deals with the role played by women in the health system – formal and informal – as providers of health care. The last section concludes with a number of suggestions for action. It is hoped that the data presented in this chapter will be of use not only to nutrition and health scientists but also to planners and policy-makers.

It is possible that some of the observations being made in this chapter may have been covered in some other chapters. This overlap is unavoidable.

Unfavourable sex ratio: This has been discussed at length in an earlier chapter and here we will briefly sum up the situation. The sex ratio (number of females per thousand males) in the country as a whole has continued to remain unfavourable, and to the disadvantage of females. This trend has been steadily worsening during the last century. The last Census Report, however, reveals marginal improvement (Figure 1), but the situation in some states continues to worsen, e.g. in Haryana, Jammu and Kashmir, Nagaland, Punjab, U.P. and Sikkim (Table 1).

Life expectancy at birth: Life expectancy at birth for the female has improved over the years. The 1980 census data based on population projections 1981-2001 actually reveal, for the first time, a higher life expectancy for the female than the male[54]. However, an analysis of the data has shown that the gain in life expectancy among females is largely attributable to increased survival of women of the older age group[34]. The female mortality is still in excess of male mortality in earlier age groups: it is only after the prime reproductive years that the gap narrows[12]. Age specific mortality rates for 1985 as

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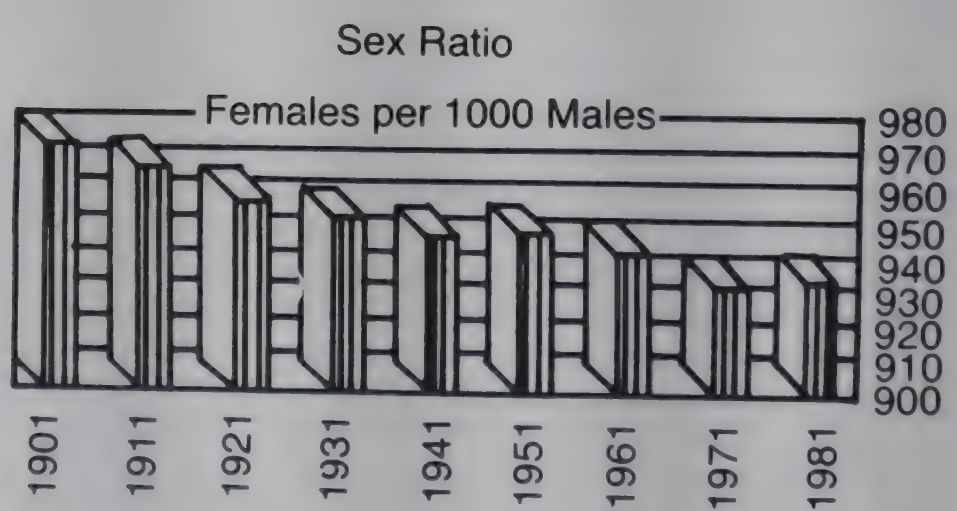
Fig. 1. Sex Ratio, 1901-1981



Source: Health Information of India, 1987, Central Bureau of Health Intelligence, Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India.

provided by the Sample Registration System of India[55] indicate that it is only beyond the age group 30-35 years that mortality rates for females are less than that of males. In urban areas, the improvement with respect to female mortality rates starts earlier than in rural areas. The important point is that higher mortality among females in infancy, childhood and reproductive years still remains high.

Mortality at different ages: While the overall total mortality is higher among males in the country as a whole, in the five northern states it is marginally higher in females[55]. A heartening feature, however, is that sex differential with respect to overall infant mortality is also narrowing, though in some of the states the sex differential is still very large, girl children being at a distinct disadvantage. The mortality rates between zero to four years and between 15-34 years, are considerably higher for females than males[55].

State-wise age and sex specific mortality rates (Table 2) also reveal some interesting information. Kerala shows higher age-specific death rates for males in all age groups unlike U.P. which shows precisely the opposite. Jammu and Kashmir, Assam and Orissa have more male deaths in the zero to four years age group. Punjab, on the other hand, has a death rate unfavourable to females only in the zero to four years age group. In Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu, male mortality begins to exceed female mortality between 30-34 years itself, while in Bihar, Haryana, Madhya Pradesh, Rajasthan and Himachal Pradesh, this happens only after the 35th year. The sex differentials in mortality are uniformly more pronounced in rural areas as compared to urban areas.

Mothers' Health And Mortality

Most Indian mothers are pregnant too frequently, malnourished, anaemic and dying of causes which could have been easily prevented.

Maternal mortality: Unfortunately, no national data on maternal mortality are available. This by itself is an indication of the low priority which maternal health is receiving in the country today. The range of mortality as available from various studies is 4-8/1000 births. The multicentric hospital-based maternal mortality study done by the Federation of Obstetrics and Gynaecological Societies of India (FOGSI) reported a maternal mortality figure of 721/1,00,000 births[67]. A community-based study done in Anantpur district[6] reported maternal mortality figures of 830/1,00,000 live births for rural areas and 545/1,00,000 live births for urban areas.

One percent of total deaths and 2.1 percent of total female deaths in rural areas[56], 0.9 percent of total deaths and 2.1 percent of total female deaths in urban areas[81] were reported to be due to maternal deaths. Table 3 which shows maternal deaths as a percentage of total deaths in different states indicates gross under-reporting of maternal deaths in some states.

Factors contributing to maternal mortality: Age of the mother is a very important factor. Most of the maternal deaths occur in the age group 15-24 years[6,56,81]. It has also been shown that the majority of mothers who had died did not have any male child and it appears that the desire for a male child resulted in many closely spaced pregnancies[6]. Antenatal care and care at delivery were significant factors contributing to maternal mortality[6,7,67]. Accessibility to health services was another significant factor[6].

Causes of maternal mortality: Table 4 shows the causes of maternal mortality from various studies in India. About 75 percent of maternal deaths[67] are due to direct or obstetric causes. Topping the list of direct causes are haemorrhage, sepsis, abortions and toxaemias all of which are preventable with good antenatal care. Deaths due to abortions (of which more than 80 percent are illegal) still contribute to about 15-25 percent of maternal deaths[67]. One wonders whether the Medical Termination of Pregnancy (MTP) Act has contributed at all to the decline in the incidence of illegal abortions; it seems likely that most abortions are still being done clandestinely to get rid of unwanted pregnancies. The indirect obstetric causes account for about 20 percent of maternal deaths[67]; 15-20 percent of maternal deaths are directly or indirectly due to anaemia[67]. Viral hepatitis is another important cause of maternal death. Again most of the indirect causes of maternal deaths are preventable. Table 5 based on various studies[6,14,66,77] indicates the percentage of avoidable causes of death.

Maternal Morbidity

Nutritional anaemia: Anaemia is one of the important causes of maternal mortality. A study by the Indian Council of Medical Research (ICMR)[79] showed the distribution of haemoglobin levels of women aged 13-49 years in rural areas as 7.3 percent with less than 8 g/dl, 27.3 percent with 8-10 g/dl and 65.4 percent with more than 10 g/dl.

A collaborative study[20] done in rural areas of Hyderabad, Calcutta and New Delhi and urban areas of Madras showed that the percentages of women with anaemia were 73.9 percent, 98.3 percent, 65.9 percent and 22.3 percent respectively in the age group 15-24 years. For the ages 25-44 years the percen-

tages were 66.8 in Hyderabad, 99.2 in Calcutta, 66.1 in New Delhi and 33.8 in Madras. Anaemia is therefore a major health problem in women.

Among pregnant women, the rates of anaemia are even higher. A high proportion of women are anaemic even at the start of pregnancy. In a study among pregnant women, it was found that while 20 percent of women are anaemic at the onset of pregnancy, over 60 percent develop varying degrees of anaemia in the last trimester[2]. Haemoglobin surveys conducted in various parts of India have indicated that 40-70 percent of pregnant women have haemoglobin levels less than 11 g/dl[65]. Studies done in Bihar and Uttar Pradesh showed that the mean heamoglobin levels in pregnancy were as low as 9.3 g/dl and 9.2 g/dl respectively[1]. Studies done on mothers living in urban slums, who had just delivered, showed that 58 percent of mothers in Calcutta, 40 percent in Bombay and 43 percent in Madras had haemoglobin levels below 10 g/dl[52]. Another study on pregnant women[64] found that 50-60 percent of women were iron deficient in the last trimester and that 10-20 percent of pregnant women were deficient in folic acid. Diets insufficient in quantity and deficient in iron and folic acid together with the demands of repeated pregnancies and lactation, deplete the stores of iron and folic acid. This may be aggravated further by hookworm infestation. Severe anaemia in pregnancy increases maternal morbidity and mortality.

Severe anaemia also increases the chances of delivering low birth weight babies as will be discussed later. Severe anaemia could also affect lactation performance[52] thus further worsening the nutritional status of the already undernourished and underweight baby.

Severe anaemia decreases maximal and near-maximal work capacity[20]. The impact of less severe anaemia on work capacity is not well defined though there is evidence that it certainly affects day-to-day life activities[20]. Also, correction of anaemia has been shown to increase work capacity [20,63]. Tiredness and apathy are common in anaemic women of child bearing age; this could be expected to lead to less care and therefore less food for their young children, thus further worsening infant nutritional status. Impaired immune status in severe forms of anaemia has also been demonstrated but there is no conclusive evidence of impairment of immunity in mild and moderate degrees of anaemia[20].

Other morbidities: Peak prevalence of tuberculosis is seen among women below 35 years of age, while in men this is above 45 years[61]. Repeated pregnancies probably contribute to this high prevalence. Tuberculosis flares up during postpartum period when the temporary pressure exerted on the lungs by the gravid uterus is relaxed.

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A case study done in Uttar Pradesh[36] showed that not only was the frequency of illness episodes more among women than among men but also the duration of each illness episode was longer. A study done in Madhya Pradesh[50] also showed that the average duration of illness was more among females.

On the other hand, there are several studies which show that there is no significant difference in morbidity rates between males and females (Table 6)[30-33,49,50,57-59]

A study of rural pregnant women in Rajasthan[10] showed that for every maternal death, there were 60 episodes of sickness of which 16.5 episodes were related to pregnancy and puerperium. Sicknesses were found significantly more during the first trimester and the puerperium. Table 7 shows morbidity pattern during antenatal and postnatal periods as reported from Gujarat, Rajasthan and North India[10,32,83]. The most common illnesses were those related to complications of pregnancy and puerperium followed by fever.

Abortion: Abortion was legalised in India by the Medical Termination of Pregnancy (MTP) Act of 1971 to deal with the problem of illegal abortions resulting in deaths. The MTPs performed per 1,000 women in the age group 15-44 years are shown in Table 8[23]. In this table Maharashtra is on top and Bihar is at the bottom. It appears that states which perform better in family planning have also done better in performing MTPs. Failure of contraception is the reason for MTP in 39.3 percent of cases (Table 8). 30.3 percent cases of MTP accepted sterilisation and 17.3 percent accepted IUDs. Though MTPs are being carried out by specialists, they are not free from complications. A study done in Surat[74] showed a complication rate of 38.9 percent which included both major and minor complications. Haemorrhage (9.6 percent) was the major complication observed. The reported rates of MTP only show the tip of the iceberg as the number of criminal and septic abortions have not apparently decreased as could be seen from hospital-based studies done in Delhi and Calcutta [60,70]. As is evident from the studies on maternal mortality and survey of causes of death, deaths due to abortions and postabortal sepsis continue to be high in the country[56,67].

Nutritional status: The surveys of the National Nutrition Monitoring Bureau (NNMB) provide an indication that a large proportion of women are undernourished. Women of child-bearing age are at greater nutritional risk than other population groups owing to the added demands of reproduction.

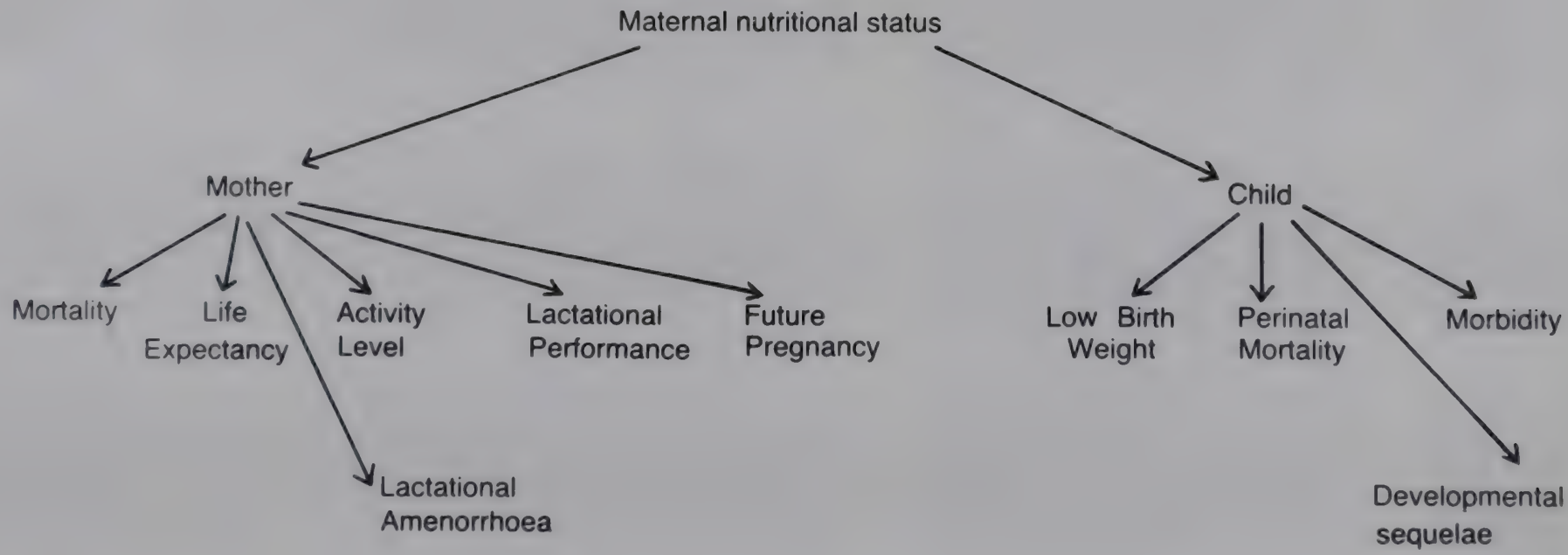
The mother's poor nutritional status during pregnancy and delivery impair her future and her ability to perform the many tasks which are her normal responsibility. It also affects the health and development of her child as shown in Fig. 2 [29]. The girl child whose growth is retarded in utero and early years of life, arrives to the stage of motherhood in poor nutritional status (Fig. 3)[29].

An ICMR study[79] among rural women of 13-49 years of age, showed that the mean height was 151.2 cm and mean weight 43.8 kg. The percentage of mothers with body weights less than 40 kg was 33.4 percent and heights less than 145 cm was 12.1 percent. The NNMB studies of 1975-79 had also shown that 12-25 percent of women 20-30 years of age had heights less than 145 cm and 15 percent to 29 percent had weights less than 38 kg[17]. These are the women who are most at risk during pregnancy or at delivery and likely to produce low birth weight babies. These women also probably do not have adequate diet during pregnancy and access to proper care during the antenatal period, at delivery and postnatally and this increases tremendously the risk to which they are subject.

The weight gains during pregnancy of poor Indian mothers average 6.5 kg. A study in Uttar Pradesh[78] showed that while the average weight gain at 39 and 40 weeks of pregnancy was 8.1 kg and 8.3 kg respectively in well-nourished mothers, the corresponding figures were 6 kg and 6.5 kg for the undernourished. It was further noted that in undernourished mothers, weight gain was mainly affected in the third trimester. Similarly, a study in Calcutta found that among the under-privileged mothers, the average weight gain was 5.33 kg with a range of "no weight gain" to 8.6 kg[13]. A poor Indian mother's caloric intake is 1400-1800 Kcals/day (as against the recommended 2500 Kcals/day) and her protein intake is 40 gm/day or less (as against the required 60 gm/day)[65]. In Ludhiana district of Punjab, it was found that pregnant women in the last trimester took 1754 Kcals and 56 gm of protein per day in non Scheduled Caste homes; in Scheduled Caste homes the intake was 1571 Kcals and 51 gm of protein per day[76]. Studies in Gujarat showed that the proportion of women who consumed less than 2,000 Kcals/day was 43 percent [15].

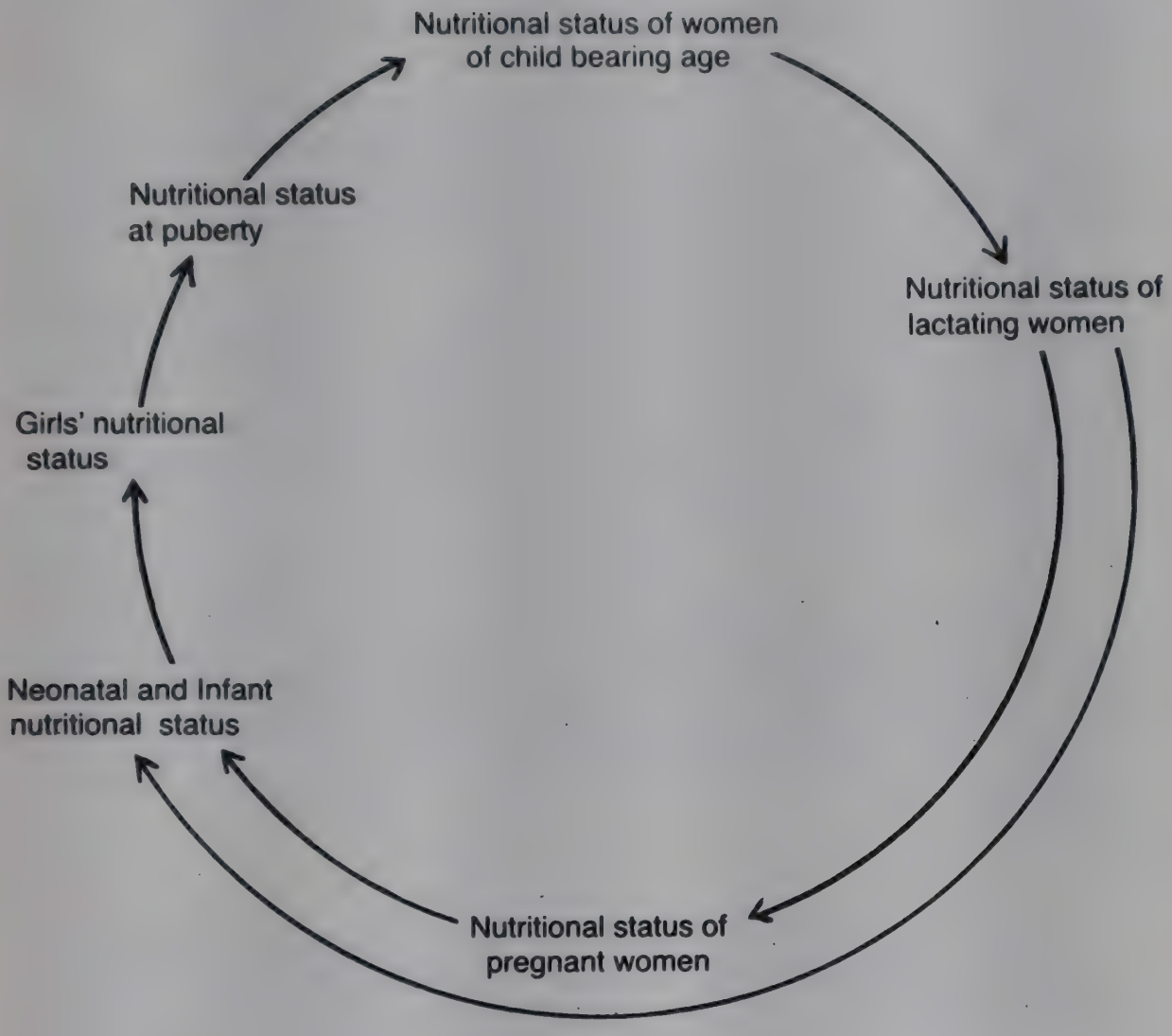
Physical stress during pregnancy: Strenuous physical activity during pregnancy is another factor which contributes to still births and premature births. Heavy physical activity among pregnant women from Jat and Ramdasia communities has been reported to have led to higher prenatal deaths[11]. Case studies from Uttar Pradesh[36] showed that mothers of poor communities continued doing heavy work right through pregnancy almost till the labour pain started. Moreover they have the additional disadvantage of having to resume work at an early date soon after pregnancy. A study in Andhra Pradesh[13]

Fig. 2. Outcomes of Maternal Nutritional Status for Herself and Her Child.



Source: J. Hofvander, Maternal and Young Child Nutrition, UNESCO Nutrition Education Series (ref. 29)

Fig. 3. Cyclical Intergenerational Influences of Maternal Nutritional Status


Nutritional status of women of child bearing age
Nutritional status of lactating women
Nutritional status of pregnant women
Neonatal and Infant nutritional status
Girls' nutritional status
Nutritional status at puberty

(Source: Reference 29)

showed that pregnant mothers were not given any extra rest throughout their pregnancy, either because they were not aware of such a requirement or could not afford the luxury of rest. 96.6 percent attended to household work during zero to nine months without any break and 65-90 percent continued with manual work. Only about 29 percent were given rest for two months after delivery. It was also shown that 14-16 hours (or nearly two-thirds of the day) were spent in working[13]. Women spent a lot of time walking long distances to collect fuel, fodder and water resulting in high calorie expenditure. The level of food intake was too low to compensate for these extra energy needs.

An ICMR report[27] showed that 20 percent of pregnancies of mothers belonging to low socio-economic groups ended in abortions or still births. Toxaemia of pregnancy is frequently the cause of maternal mortality among poor-income groups subsisting on poor diets. The role of deficiency of folic acid in causing toxaemia, accidental haemorrhage, pre-maturity, postpartum haemorrhage and puerperal sepsis is well known[27]. Inadequate diets also affect placental function leading to low birth weight. All the above adverse outcomes were seen in low socio-economic groups where antenatal care also was probably poor. Such multiple factors contribute to the poor pregnancy outcome in the poverty stricken communities.

Fertility: Any discussion on maternal health is incomplete without discussions on the state of maternal fertility. The mean age of girls in the country at marriage, as of 1981, was 18.3 even though the mean age at marriage varied from state to state, being lowest (16.09) in Rajasthan and highest (21.85) in Kerala[25]. The percentage of married females in 1981 in the rural area for the age group 10-14 years was 7.82 percent and for the age group 15.19 years was 48.92 percent.

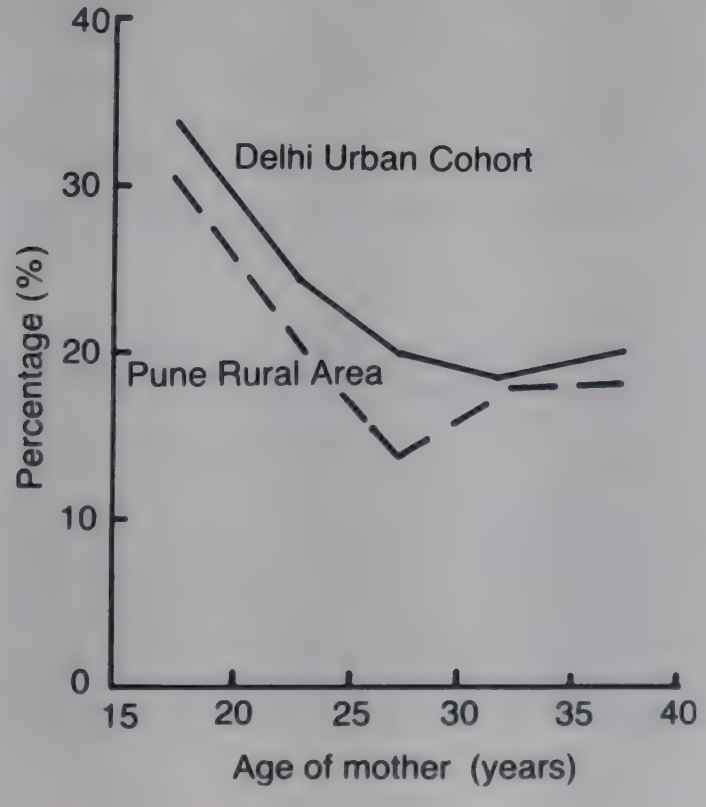
Several studies have shown the relationship between age at marriage, fertility, child survival and mother's own survival. Having babies at the right age with the right birth interval and right number of children is essential for the survival of both mother and child. Several studies have shown that mothers whose ages are either below 20 years or above 30 years, whose birth intervals are less than 24 months, and who have a parity of three +, experience high infant mortality and maternal mortality[6,15,40,46] (Table 9). The WHO international collaborative study[85] done in Gandhigram in South India clearly showed that the least pregnancy wastage took place in mothers of 20-29 years. The relationship between foetal, perinatal, infant and child mortality and birth order followed a U-shaped curve as the foetal wastage and perinatal neonatal mortality was still high for first birth order and then decreased and started rising after the third child. Similarly with increasing parity obstetric complications like placenta praevia, abruptio placentae, malformation of foetus, postpartum haemorrhage, anaemia, toxaemia and rupture of uterus

were on the increase resulting in increasing maternal mortality. Infant mortality was highest for mothers below the age group of 20 years[53]. Fig. 4 shows the relationship between maternal age and incidence of low birth weight[62].

Mothers' role in child survival: The importance of maternal health/nutrition as a determinant of the condition of the offspring is still not well recognised in the actual implementation of health programmes in the country[84]. Low birth weight in the offspring contributes to high perinatal mortality. The factors responsible for low birth weight are mainly maternal factors like nutritional and anthropometric status, haemoglobin level, age and parity. Studies carried out at the National Institute of Nutrition (NIN)[19] and by the Nutrition Foundation of India [51] serve to underscore the relationship between maternal stature and incidence of low birth weights.

In Uttar Pradesh it had been shown that mothers gaining less than 5 kg weight during pregnancy gave birth to newborns with birth weights less than 2500 gm in nearly 62 percent cases[78], while mothers who had gained 7-9 kg during pregnancy, gave birth to infants who weighed more than 2500 gm in 64 percent of cases[78]. The inverse relationship between maternal caloric and protein intake on the one hand and infant mortality on the other has also been highlighted in another study from Gujarat[15].

Fig. 4. Percentage of Singleton Birth Weight by Age of Mother in Pune Rural Area and Delhi Urban Cohort, India



In developing countries maternal anaemia accounts for high rates of foetal loss (12-28 percent), perinatal deaths (30 percent) and neonatal deaths (seven to 12 percent). The remaining live births have around a 50 percent chance of resulting in a low birth weight baby[2]. A multicentric study on perinatal mortality[44] found that 29.3 percent of all women who experienced perinatal deaths, suffered from anaemia (less than 8.5 g haemoglobin per 100 ml). The same study also showed a direct relationship between the severity of anaemia and the weight of the infant on one side and incidence of perinatal morbidity on the other. The "Odds Ratio" of the characterisitics among perinatal mortality cases as set against the controls are highest for variables pertaining to maternal and reproductive health and lowest for socio-economic variables showing a stronger linkage between women's health and reproductive health to perinatal survival (Table 10).

Prenatal health care has a very positive correlation to health and survival of the infant. It was seen that mothers of low birth weight babies registered for antenatal care only in the third trimester and the number of visits to the ante-natal clinic was low (less than three on an average)[80]. Another study showed that the number of perinatal deaths including still births were 10 times more in case of mothers with irregular antenatal attendance[9]. Similar findings were also found in a study done in Haryana[40].

A report from Ludhiana[8] showed that good antenatal care, increased intake of food during pregnancy, prevention of anaemia and early detection of complications resulted in a decrease in incidence of low birth weight babies, and a lower neonatal mortality in the privileged sections of the population. In this group it was easy for the pregnant woman to get more food, more rest, and attend clinics for antenatal care. This was not the case with the women of poor landless labourers (approximately 30 percent of rural communities). Poverty and over-work with resultant inability to have contact with health care providers further deteriorated the conditions of mothers and their infants.

The "cost" of reproduction: A computation done on the time spent by an average Indian woman in pregnancy and lactation[69] showed that in the reproductive span of 15-45 years, a woman becomes pregnant about eight times with an abortion/still birth rate of 15 percent,infant mortality rate of 122, child mortality rate of 18 and she ends up with three to five live children. Breast feeding is done till the child is two to three years of age, with maximal breast milk output in the initial 18-24 months. A woman spends about 194 months of a total of 360 months of her reproductive life in pregnancy and lactation, most of which when she is still less than 35 years of age. Nutritional depletion during this period could be substantial; and most mothers are malnourished to begin with.

Adolescent Girls

It is not long before the under-five-year-old girl of today will become a bride and a mother. A high percentage of Indian girls spend the second and third years of their lives in varying degrees of malnutrition. A second spurt of growth occurs at puberty. Nutritional deprivation coupled with early pregnancy could be expected to retard and reduce the girl's adolescent growth.

Adolescent girls are usually the foster mothers of their younger siblings. Education and training will prepare them better not only for their own motherhood, but would also enable them to play their present role as future mothers. A proposal for an imaginative programme of "Education for better living and vocational training" beamed to adolescent girls had been strongly advocated by the Nutrition Foundation of India.

Marital status: The picture projected by several small-scale studies suggests that the position with respect to mean age at marriage is even worse than what may be presumed from the census report; these studies show that in pockets of the country the age of girls at marriage is actually much lower. However, surveys done in backward districts of different states showed that age at marriage is much lower (Table 11) [30-33,49,50,57-59]. Knowledge of legal age at marriage was very poor among currently married women interviewed in the same surveys. A study done in the rural areas of Rajasthan, Delhi and Uttar Pradesh to look at the problems and needs of adolescent girls[43] showed that 21.75 percent of the girls 10-16 years old were married, 14 percent engaged and 9.25 percent had parents actively looking for a husband; the figures were even worse for Jaunpur in Uttar Pradesh where 10.3 percent of the married girls were married at the age of eight to 10 years, 32.7 percent at the age of 11-12 year, 20.7 percent at 13-14 years and 36.8 percent at 15-16 years. The above figures clearly show that quite a large percentage of girls still get married during early adolescence.

An estimated (at least) 10-15 percent of all annual births are among early teenage mothers[24].

Nutritional status: Table 12 shows the heights and weights of girls aged 10-16 years from the NNMB data for 1984. On the basis of NNMB data in Table 12 it has been computed that a very high proportion of girls are at high obstetric risk not only at their 18th year, but at much greater risk in their 14th or 15th year (using the WHO risk criteria of height less than 145 cm and weight less than 38 kg)[16,18].

Mortality rates: The all-India estimated age-specific death rate for 1985 is 1.8 for males and 1.9 for females in the age group 10-14 years and 1.9 for males and 2.8 for females in the age group 15-19 years[55]. The sex differential is more pronounced in the age group 15-19 years, probably because of maternal deaths. It will thus be seen that maternal death becomes an important factor well before the 20th year.

Causes of deaths: Table 13 shows causes of death in the age group five to 14 years[56]. Sex differential is seen for all causes except digestive disorders. The striking sex differential with respect to deaths due to respiratory disorders to the disadvantage of the females is noteworthy. This may be due to the fact that most adolescent girls spend most of the day cooking in unhygienic, ill ventilated kitchens and the smoke inhaled continuously may be the underlying factor.

Clinic attendance: According to one study, less than seven percent of girls 10-14 years attended the clinic compared to 11 percent of boys in same age group[73].

Anaemia: No specific data on the prevalence of anaemia among the girls of age group 10-16 years is available. The collaborative study done in Hyderabad, Calcutta, New Delhi and Madras[20] showed that among girls of six to 14 years, the prevalence of anaemia was 63.8, 98.7, 65.7 and 12.4 percent. The two extreme figures of 12.4 percent (Madras) and 98.7 percent (Calcutta) appear questionable. Obviously there is a clear need for better standardised surveys of haemoglobin levels of adolescent girls in the country. With the adolescent growth spurt, the haemoglobin levels may be expected to go down. This along with low intake and bioavailability of iron in cereal-based diets worsens the problem of anaemia. Hookworm infestation is common in many parts of the country. It is with the poor levels of haemoglobin caused by these factors, that the adolescent girl enters motherhood.

Knowledge, attitude and practice of adolescent girls: A study on rural adolescent girls[43] showed that 65.5 percent of the parents did not impart any knowledge related to child-bearing and rearing to adolescent girls. Mothers never spoke to their daughters about physical changes at puberty and few talked about menstruation to their adolescent daughters.

Of the 87 who were married in the study sample, 24.8 percent knew that a woman can get pregnant after the onset of menstruation. Though half of the married or engaged girls wanted a small family only 9.4 percent knew anything at all about birth control.

Only 13 percent of the total number of adolescent girls interviewed knew anything about child birth. Breast feeding was well accepted as the norm for infant feeding.

Health Service Utilisation Patterns Among Women

Awareness and utilisation of government health facilities and personnel by non-pregnant women: Data on the pattern of utilisation of health facilities by women are available from very few sources. It is evident from Table 14 that the awareness among females about the availability of government health facility is low. The percentage of women who visited a health facility was around 35 percent but most visits were made not for their own illness but for those of their children or others in the family. Studies have shown that women seek health care only very late in their illness[36,72] and tend to neglect their own illness. This is partly due to ignorance, due to the attitude of not wanting to trouble their husbands, and partly due to the consideration that household work would suffer if they went to a health centre. A women's illness is apparently not a pressing "felt need" for seeking health care till she is really sick.

Compared to the awareness about the availability (and indeed the very existence) of the female health worker (ANM), the awareness about the "existence" of health guides and *dais* at the village level was greater (Table 14). The number of homes visited by the health worker (female) was very small. A study reports that only seven to eight percent of women were visited at home by health workers[36]. Domiciliary health care by ANMs seems totally inadequate in the absence of a system for this purpose. Contact between female health functionaries and women of the village, on the whole, appears to be very small, and wholly inadequate.

Awareness And Utilisation Of Government Health Facilities And Personnel By Mothers During Antenatal, Intranatal And Postnatal Period

Antenatal care: Baseline surveys done in backward districts in different states[30-33,49,50,57-59] showed that the percentage of pregnancies reported was very small. This was the case even when health centre records were reviewed. A study done in Jaipur[82] showed that there was poor coverage for registration for antenatal care and postnatal care infants, toddlers and eligible couples. The study also showed that records were not only incomplete but also poorly maintained.

Table 15 shows that very few pregnant mothers had been registered in the health centre; that very few had had check-ups in the clinic; and that very few received iron and folic acid tablets and tetanus toxoid injections. Even mothers who knew about the availability of services did not feel the need to avail of it,again confirming the fact that pregnancy is not considered "important". Even among those who are registered, most were registered after the sixth or seventh month of pregnancy. Most clinic visits were one time visits only. Since only a small percentage of pregnancies had been registered to start with, the actual coverage with MCH services was even smaller. This coverage would be even less in villages further away from the health facility and among the underprivileged sections of the community[42]. A multicentric study done by ICMR[28] to assess the role of health delivery services in Gujarat, Rajasthan and U.P. showed that 40-45 percent women of the community were unaware of antenatal services. Data in Table 16 further confirm the low utilisation pattern.

A study in Himachal Pradesh[71] indicated that just 24 percent of pregnant women actually received iron and folic acid tablets as against 75 percent who claimed to have received these. From the figures in Table 15 showing pregnant mothers who had received iron and folic acid, one does not know whether they had actually received the "standard 90 tablets" to which every pregnant mother is entitled. Considering most clinic visits are one time visits, it is most unlikely that the mothers had received the full quota of tablets. The figures on tetanus toxoid coverage do not indicate whether "two dose protection" or just a single dose was delivered.

Over 17 percent and 25.2 percent of pregnant mothers with illnesses in Maharashtra and Gujarat respectively[30,32] were reported to have utilised Primary Health Centre or sub-centre facilities. Studies done in North India[83] had shown that for serious problems like bleeding per vagina and vaginal infections, private practitioners were favoured[83]. Government health facilities were mostly used for complaints of fever.

Intranatal care: Kerala has a high proportion of institutional deliveries; in Punjab and Haryana, births attended by trained professionals at home are high[55]. Table 17 which indicates the type of attention at birth as gathered from various studies[30-33, 37,42,45,49,50,57-59], shows that most deliveries are being conducted by untrained *dais*; and in Orissa, Maharashtra and Uttar Pradesh (U.P.) mostly by friends or relatives. The percentage of deliveries conducted by untrained persons is more in villages not located in the vicinity of the Primary Health Centre or sub-centres.

It is unfortunate that in spite of large numbers of *dais* who have been trained, most deliveries are still being attended by untrained professionals. Type of care at birth has a major role to play in determining survival of the mother and infant[7,40].

Postnatal care: Most neonatal deaths and maternal deaths take place during the first seven days after delivery. Yet this period does not get adequate attention.

The ICMR study[79] showed that only 36 percent of mothers in postnatal period were visited by health workers in the first three days after delivery, 35 percent visited in four to seven days after delivery and 29 percent visited after eight days. Of those who were visited, 72 percent were examined in the first three days, 19 percent in four to seven days and 9.1 percent in eight days or more. Table 16 and 18 show that a very small percentage of mothers were visited by health workers after delivery except in Gujarat. Similarly, visits to the health centre by mothers after delivery is small except in Gujarat. In most cultures, mothers and their new born babies are not allowed to move out of the house. Therefore, it is not surprising to see such low percentages of visits to the health centre. Only 48.45 percent in Gujarat and 12.88 percent in Maharashtra[30,32] used a Primary Health Centre or sub-centre facility for problems in the postnatal period.

Srinivasan *et al.*[75] showed that mothers who were more receptive to maternal care would utilise the services better, would register themselves in the first trimester, visit the antenatal clinic periodically, get protected with tetanus-toxoid and get skilled intranatal care. The study found that mothers with lowest maternal care receptivity scores had the highest perinatal and neonatal mortality rates. These findings underscore the importance of antenatal care and intranatal care in perinatal and neonatal mortality. Education of mothers and their better motivation will contribute significantly to improved utilisation of health services and better health.

Family welfare: The expenditures on family welfare operations have been steadily increasing over the Five Year Plan periods. There has been a great stress on spacing methods of contraception in recent years. Table 19 shows that the knowledge of currently married women about spacing methods is, however, very poor. This finding has been confirmed by other studies[3,22]. Health workers were *not* the main source of information regarding various methods. This indicates poor contact between health personnel and women in the community. Surprisingly not a very high percentage of couples were sterilised and the use of spacing methods was negligible. Similar findings were also noted in the ICMR study[28].

The health worker had motivated very few of the women in accepting tubectomy. The ICMR study on health service utilisation[28] showed that female health workers motivated 62 percent of women in Gujarat, 18 percent of women in Rajasthan and 39 percent in U.P. Health workers gave advice regarding family planning before delivery in 13 percent, 4.03 percent and 9.6 percent women from Himachal Pradesh, Haryana and Punjab respectively and in 9.2 percent, 13.06 percent and 16.6 percent after delivery. Postnatal period is the best time to motivate, as the mother is most receptive at this time. Findings from Madhya Pradesh[50] showed that the health worker (female) talked to only 8.4 percent of currently married women about family planning and MCH. That the contact of health workers with mothers for family planning services was poor is evident from the studies mentioned. Family welfare is reported to be an important activity for a health worker and it is also said that a lot of time is being spent on this activity, at the cost of other activities. Yet, the reach of even this service is very poor.

Medical termination of pregnancy (MTP): Table 20 provides data regarding knowledge about MTPs among currently married women. The awareness of this service is poor and probably this is the reason for low utilisation rates shown in Table 20. MTP has been legalised to help women; yet the rate of criminal abortions, which contribute to maternal morbidity and mortality, is high.

The special case of Kerala: Kerala, in spite of its high population density, low per capita income and low calorie intake, has the lowest mortality rates, especially female mortality, and the highest family planning coverage. Status of women, high female literacy, accessibility to health services and utilisation have been mentioned as some of the factors responsible for this picture.

Several studies have been done in India comparing Kerala with other states with respect to ut lisation patterns. Kerala being more densely populated, the "catchment area" of a Health Centre or sub-centre is smaller. In other states, the catchment area of a health facility is larger due to a scattered population. This spatial distribution could be an important determinant of utilisation of health facilities. In a comparative study of West Bengal and Kerala[47] it was seen that in rural Kerala the utilisation of preventive and curative medical facilities was much more than that of West Bangal. The catchment area of Primary Health Centre for both states was more or less similar. Women in Kerala utilise MCH services better and use skilled intranatal care, resulting in higher maternal and child survival. In another comparative study of Bihar and Kerala[38] it was shown that the availability of a doctor at a Primary Health Centre was much greater in Kerala and that the mean waiting time for a patient to see a doctor was 79 minutes in Bihar while in Kerala it was 10 minutes. These factors could have an important role to play in utilisation of health services by women.

Women As Health Care Providers In The Health System

Almost 75 percent of India's health system workers in the periphery are women — the *dais*, women health guides and health workers (female). The health assistants (supervisors, female), the various levels of nurses and lady doctors form the rest of the women health care providers. The *dais* and health guides are not part of the "formal government health structure". One thing common for most of these women is that they play a dual role — as providers of health in the formal system, and in their own homes.

A very large number of women health care providers have been trained in the country[25]. Yet, the numbers are not adequate enough to reach the norm of one health guide per 1,000 population or one trained *dai* per 1,000 population and one health worker per 5,000 population. The worker to population ratio is even smaller for hilly and tribal areas. The worker population ratio is worse in states like Uttar Pradesh, Bihar, etc. The great push by some states to post female health workers in hospitals adds to the shortage of trained workers in the rural areas.

Women In The Formal Health System

Deficiency in training: Several studies done in India have shown the deficiencies in the training programmes; virtually no in-service training takes place. An assessment done in Punjab, Haryana, Himachal Pradesh, Maharashtra and Gujarat[21] showed great gaps in knowledge and skills of female health workers, their supervisors and *dais* particularly in the area of intranatal care and care of the new born. Other studies have also confirmed deficiencies in training and gaps in knowledge and skills of female workers[26]. A comparative study of Bihar and Kerala[38] showed that female health workers in Kerala were better trained than those in Bihar.

Perceptions about functions and clients: The ICMR study on U.P., Rajasthan and Gujarat health care providers[28] showed that while in all three states the functionaries were concentrating on Family Planning (F P) "motivational" work, it was only the functionaries of Gujarat that paid attention to the provision of MCH and health services as well. Comparative studies of Kerala and Bihar[38] showed that while the workers from both states reported F P work as the most common work done, a higher percentage of workers from Kerala compared to those from Bihar, were delivering services such as care of the new born, immunisation services for children and home visits. The ICMR study[28] also showed that the time allocated to F P in U.P. and Rajasthan was greater compared to that for other services. Apparently health workers in the

"backward" states were "concentrating" on family-planning to the neglect of other components of health care; even more unfortunately they were apparently doing the job which they were "concentrating" on poorly.

In-depth case studies showed that in Kerala 82 percent of women were motivated for family planning while the figure in Gujarat was 34 percent and 20 percent in Bihar[45]. It was also seen that workers found that "low caste" and tribal people were the most difficult to motivate. This is consistent with the findings that the most needy who have high birth rates, high infant and maternal mortality and with severe degrees of malnutrition among their children are precisely the ones that are poorly reached. One wonders whether the "difficult to motivate" concept is being used as an excuse not to deliver services. Studies done in Bihar have shown that very poor women actually do not get any service from health workers[39]. This is an aspect that our health administration should look into. Where does the fault lie – in the provider or the "beneficiary"? Are we blaming the latter unjustly?

Performance of health workers: A factor contributing to the performance of health workers is the workers' own attitude and practice regarding health and F P. A study done in Punjab, Haryana, Himachal Pradesh, Maharashtra and Gujarat[22] showed that most health service providers were *not* convinced about *most* of the messages which they were expected to convey to the community. The health care providers shared the same inadequate knowledge and poor motivation as the population they served. The average size of the families of health functionaries was smaller than that of the community they served only in Kerala but not in Bihar[38].

Poorly trained workers, with negative health and family planning attitudes and practices and under poor supervision, cannot be expected to perform their functions well. The workers are also not reaching the women (most in need) – the women from underprivileged sections of the community.

Women in the informal health system: Health guides and *dais* form part of the informal health system. In 1981, the Government of India had decided to select women as health guides. A collaborative study by the National Institute of Health and Family Welfare in 1984[48] had shown in 63 percent of cases that the criteria for selection of health guides could not be adhered to. Selection of female health guides was found to be specially difficult. Health guides played little role in MCH programmes probably due to lack of sufficient training. However, in the relatively few instances where well-trained female health guides existed, more women approached them. Therefore, with proper training of female health guides, it is possible that they could play a useful role in improving the health of women in their communities.

As was pointed out earlier a large number of *dais* have been trained in the country[25]. Yet, most deliveries are now being conducted by untrained persons (Table 18). The training needs assessment study conducted in Punjab, Haryana, Himachal Pradesh, Gujrat and Maharashtra[21] showed that trained *dais* had great gaps in knowledge and skills in antenatal care, midwifery care, care of the newborn and family planning.

Other evaluations of *dais* training[4,5,35,41] also showed that there were no significant differences in the practices of trained and untrained *dais*, and in the number of deliveries in the community conducted by trained and untrained *dais*. The percentage of mothers registered for antenatal care was small in both groups. There was marginal improvement in the quality of antenatal advice given by the trained *dais* as compared to the untrained ones; and measures to prevent sepsis like boiling of instruments, washing of hands etc. were more frequently practiced by trained *dais*. The communications-needs assessment done in Punjab, Haryana, Himachal Pradesh, Gujarat and Maharashtra[22] also showed negative attitudes among trained *dais* to good maternal care practices. All the above findings show that the quality of the present training programmes is poor and underscore the importance of good quality of training.

Some Suggestions

New strategies should be designed to improve the health of women. For example, use of elderly village women to take care of few families in their locality like the "community mothers" in a project in Calcutta, is well worth further study. Several other voluntary health projects have also successfully used women leaders in reaching women. Mahila mandals which are either non-existent or most of which are currently in a state of suspended animation, need to be activated and made responsible for monitoring quality and reach of health services in their areas. In fact, the village level workers should be made accountable to the mahila mandals.

Special programmes for "adolescent girls" should form part of the health strategy. Health programmes should focus on this group and develop appropriate indicators to monitor the health of this group. Programmes for imparting knowledge in health, family planning, child bearing and rearing should be developed. This has short term and long term benefits as these are the foster mothers of today taking care of the siblings and they will be the mothers of tomorrow.

Table 1

Sex Ratio in States and Union Territories of India

India/State	Total	Rural	Urban
India*/ **	933	951	878
Andhra Pradesh	975	984	948
Assam	901	917	768
Bihar	946	963	832
Gujarat	942	959	905
Haryana	870	876	849
Himachal Pradesh	973	989	795
Jammu & Kashmir	892	897	875
Karnataka	963	978	926
Kerala	1032	1034	1021
Madhya Pradesh	941	956	884
Maharashtra	937	987	850
Manipur	971	971	969
Meghalaya	954	965	904
Nagaland	863	899	688
Orissa	981	999	859
Punjab	879	884	865
Rajasthan	919	950	877
Sikkim	835	864	697
Tamil Nadu	977	987	956
Tripura	946	945	957
Uttar Pradesh	885	893	845
West Bengal	911	947	819
Union Territories			
Andaman & Nicobar Islands	760	774	720
Arunachal Pradesh	862	881	629
Chandigarh	769	688	775
Dadra and Nagar Havel	974	981	884
Delhi	808	810	808
Goa, Daman and Diu	981	1013	919
Lakshadweep	975	986	963
Mizoram	919	928	893
Pondicherry	985	977	992

**Includes proposed figures of Assam where census could not be held due to disturbed conditions prevailing there at the time of 1981 census.*

*** The population figures exclude population of area under unlawful occupation of Pakistan and China where census could not be taken.*

Ref. 24

Table 2

Estimated Sex Specific Death Rates 1985 (0-4 and 15-39 Years)

All India/ States	0-4 Years		15-19 Years		20-24 Years		25-29 Years		30-34 Years		35-39 Years	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
All India	36.6	40.4	1.9	2.8	2.6	3.7	2.8	3.5	3.4	3.8	4.2	3.8
Andhra Pradesh	29.4	28.6	1.8	2.6	2.0	3.0	3.2	3.4	3.9	3.6	3.7	3.4
Assam	44.7	41.3	1.7	3.4	2.5	4.8	3.1	4.3	3.3	4.4	5.7	6.2
Bihar	44.8	52.4	2.3	4.2	2.7	5.9	4.1	5.7	3.4	5.6	4.2	3.6
Gujarat	37.0	37.6	1.4	2.2	2.9	3.5	2.8	3.0	3.4	2.9	4.9	4.3
Haryana	25.7	34.4	1.4	2.8	2.2	2.8	1.3	3.8	2.7	3.8	3.5	3.1
Himachal Pradesh	25.2	28.9	1.1	2.6	2.8	4.2	3.0	3.3	3.7	7.3	4.4	1.8
Jammu & Kashmir	32.6	28.0	1.4	1.7	0.9	1.8	0.9	2.7	1.3	3.4	3.1	6.5
Karnataka	24.6	24.8	2.1	2.3	2.4	3.0	2.0	2.4	3.0	2.3	2.9	3.7
Kerala	11.2	9.2	0.9	0.5	1.4	1.0	2.4	1.0	3.0	1.2	3.2	1.1
Madhya Pradesh	52.3	54.3	1.8	3.3	2.6	3.6	2.5	2.6	3.8	3.9	5.2	3.5
Maharashtra	21.5	25.2	1.4	1.4	2.3	2.8	1.7	2.2	4.4	2.6	4.2	1.9
Orissa	47.0	46.3	2.6	3.2	3.4	4.9	2.8	4.8	3.8	7.1	4.6	5.8
Punjab	23.7	29.2	2.4	1.4	2.4	2.0	3.8	2.3	4.2	2.2	5.4	2.3
Rajasthan	43.9	47.2	1.0	4.8	2.7	4.0	2.8	3.9	3.3	4.3	3.9	2.0
Tamil Nadu	24.2	27.1	2.1	2.7	3.1	3.8	3.0	3.0	2.8	2.3	4.9	4.2
Uttar Pradesh	48.4	60.1	2.4	3.1	3.1	4.8	3.1	4.9	3.2	5.6	3.7	5.3
West Bengal	27.9	26.7	1.7	3.2	2.0	3.2	2.5	3.4	3.4	2.7	3.3	4.4

Source: Sample Registration System, 1985, Office of Registrar General of India.

Table 3

Deaths due to Childbirth and Pregnancy (Maternal Deaths) as a Percentage of Total Deaths in Different States in 1986

States	Total deaths	Maternal deaths	Percentage
Andhra Pradesh	1363	17	1.2
Arunachal Pradesh	11	0	0
Assam	308	8	2.59
Bihar	1318	16	1.2
Goa	73	0	0
Gujarat	1038	5	0.48
Haryana	473	2	0.42
Himachal Pradesh	158	0	0
Jammu & Kashmir	88	1	1.13
Karnataka	785	12	1.5
Kerala	315	1	0.31
Madhya Pradesh	1542	19	1.2
Maharashtra	2988	24	0.8
Manipur	47	2	4.2
Meghalaya	22	2	9.0
Nagaland	12	0	0
Orissa	762	5	0.65
Punjab	1239	3	0.2
Rajasthan	1118	18	1.6
Tamil Nadu	1593	8	0.5
Tripura	63	1	1.5
Uttar Pradesh	2654	29	1.09
West Bengal	46	0	0
Dadar, Haveli	191	3	1.5
Delhi	55	0	0
All India	18262	176	0.9

Source: Survey of causes of deaths, 1986, Office of Registrar General of India.

Table 4

Causes of Maternal Deaths

Place of Study	RGI Rural	Anantpur Rural & Urban	RGI Urban	FOGSI Hospital
Year	1986	1986	1980-1983	1978-1981
Source: Reference	(56)	(6)	(81)	(67)
Direct obstetric causes:				
Haemorrhage	21.6%	19.5% (includes haemorr-hage of placenta)	11.3%	17.3%
Abortion	8%	10.1%	14.7%	15.1%
Sepsis	13.1%	36%	19.6%	17.2%
Malpresentation/accidents	6.3%	–	2.2%	5%
Toxaemia	12%	9.2%	14.6%	10.7%
Others	22.2%	–	19.4%	11.5%
Indirect obstetric causes:				
Anaemia	17%	9.2%	—	7.8%
Jaundice/Heart		9.8%	—	15.4%
diseases	—			—
Others	—		12.0%	

Table 5

Preventable vs. Non-preventable Deaths

Place of Study	Anantpur	FOGSI Study	Ahmedabad	Varanasi
Year of Study	1986	1978-1981	1971-1978	1976
Source: Reference	6	66	14	77
Preventable	40.8%	69.00%	91.1%	60.00%
Non-preventable	22.2%	5.7%	5.0%	NA
Unexplained/Doubtful	37.0%	25.3%	4.0%	NA

NA: no figure available.

Table 6

Morbidity Pattern Among Females from Various Community Surveys

Place	Bihar	Orissa	Rajasthan	Madhya Pradesh	Maha-rashtra	Gujarat	Himachal Pradesh	Haryana	Punjab
Year	1981	1982	1980	1985	1983	1983	1982	1982	1982
Period of reporting morbidity	3 months	3 months	3 months	24 hours	24 hours	24 hours	One month	One month	One month
Source: Reference	33	31	49	50	30	32	58	57	59
Morbidity rate per									
100 males	12.18	17.3	9.75	7 (one month	4.29	4.05	13.88	7.75	16.85
100 females	11.75	17	8.9	6.6 prevalence)	4.71	3.3	15.31	7.86	15.87
Type of morbidity									
Pain/Ache	2.21	1.3	1.1	0.30	0.0	0.0	3.76	0.61	0.69
Fever	4.03	7.9	3.6	1.22	2.53*	0.85*	3.46	2.94	3.97
Malaria	1.95	0.5	1.15	–	0.25	0.0	1.14	0.45	6.76
T.B.	0.11	0.1	0.0	0.04	0.08	0.2	0.0	0.0	0.0
Digestive disorder	0.68	1.7	0.05	0.07	0.10	0.45	0.46	0.21	0.0
Respiratory disorder	0.61	0.3	0.35	0.27	0.51	0.35	0.71**	1.07	0.7
Gynaecological trouble	0.39	0.9	0.15	0.0	0.0	0.0	0.0	0.0	0.0

Continued overleaf

Table 6 contd.

Place	Bihar	Orissa	Rajasthan	Madhya Pradesh	Maha-rashtra	Gujarat	Himachal Pradesh	Haryana	Punjab
Year	1981	1982	1980	1985	1983	1983	1982	1982	1982
Period of reporting morbidity	3 months	3 months	3 months	24 hours	24 hours	24 hours	One month	One month	One month
Source: Reference	33	31	49	50	30	32	58	57	59
Anaemia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.19
Worms	0.07	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Injury	0.1	0.1	0.1	0.04	0.02	0.1	0.2	0.0	0.0
Leprosy	0.04	0.0	0.0	0.01	0.06	0.0	0.0	0.0	0.0
Others	1.55	4.8	1.85	1.97	0.84	1.35	0.76	0.9	1.34

* *includes coughs, colds.*

** *includes bronchopneumonia.*

Note: unweighted averages have been used.

Table 7
Morbidity during Pregnancy and Puerperium

Area	Rajasthan		North India		Gujarat	
Year	1979		1982		1983	
Source: Reference	10		83		32	
Total number of mothers	Antentatal 349	Postnatal 338	Antenatal 333		Antental 1956	Postnatal 1961
Number of mothers with problems	99	170	128		155	89
Type of problems						
Fever	8.5%	0	33.9%		1.65%	1.1%
Night blindness	0	0	0		0.35%	0.25%
Respiratory problems	2.5%	0	0		0	0
Infective and parasitic diseases	2.5%	23.5%	0		0	0
Gastrointestinal problems (diarrhoea, dysentery, constipation).	0	0	18.9%		1.05%	0.5%
Diseases of skin and subcutaneous tissues.	2.0%	11.76%	0		0	0
Weakness/aches & pains	0	0	10.8%		0.45%	0.4%
Headache	0	0	0		2.2 %	1.5%
Anaemia	0	0	0		0.2 %	0.2%
Excessive vomiting	0	0	13.2%		0	0
Pain or heaviness in lower abdomen	0	0	17.1%		0	0
Bleeding per vagina	0	0	10.8%		1.1 %	0.25%
Swelling over feet and hands	0	0	7.1%		0.08%	0.3 %
Other complications of pregnancy, childbirth and puerperium	6.8%	52.94%	0		0	0
		6.8%		52.94%		48.2%		3.5%		2.25%
Others	5.7%	11.76%	16.2%		0	0

Table 8

State-wise Medical Termination of Pregnancies (MTP) Performed During 1985-86

State	Medical Termination of pregnancies performed per 1000 women(15-44 years)	Percentage showing contraceptive failure as reason for termination	Percentage of MTP cases who accepted sterilisation	Percentage of MTP cases who accepted IUD
Andhra Pradesh	1.9	9.3	27.6	9.2
Assam	-*	5.9	18.4	11.8
Bihar	1.0	–	–	–
Gujarat	4.7	44.0	29.3	22.7
Haryana	8.7	29.7	28.6	10.3
Himachal Pradesh	9.9	91.8	39.3	19.7
Karnataka	4.0	40.7	18.5	23.6
Kerala	10.6	31.0	14.1	15.2
Madhya Pradesh	3.6	38.7	23.1	18.1
Maharashtra	16.9	65.9	11.3	26.5
Orissa	5.9	34.1	22.1	16.3
Punjab	12.5	82.8	37.5	39.4
Rajasthan	3.5	13.3	32.5	20.1
Tamil Nadu	11.5	5.5	86.3	7.4
Uttar Pradesh	6.1	48.5	16.7	7.4
West Bengal	5.9	24.4	51.7	14.0
All India	6.7	39.3	30.3	17.3

Reference: 23

** 1981 census figures for the age group 15-44 years not available. Hence the rate could not be calculated.*

Table 9

Nutritional Status of Child Just Elder to the Youngest Child in the Family in Relation to the Birth Interval between Them

Interval between births (months)	Number of the elder under-fives	Nutritional status (Percent of the standard)	
		Below 70%	Above 70%
⩽ 12	4	3 (75.0%)	1 (25.0%)
13-24	36	21 (58.3%)	15 (41.7%)
25-36	31	12 (38.7%)	19 (61.3%)
37-48	15	6 (40.0%)	9 (60.0%)

Source: Ref. 46

Table 10

Differential Patient Profile for Perinatal Mortality (PM) Cases and Controls – Considerations of Socio-economic Status, Health and Reproductive Percent Status Total and ODDS Ratios (OR)* (FOGSI 1977-79 PM Survey; 123 Centres, 10,285 Deaths)

Factors of three areas of intervention	Classification	Percent of women with classified factors under study		
		PM Cases (N=10285)	Controls (N=20957)	ODDS Ratios* (OR)
A. Socio-economic status				
1. Residence	Rural VS. non-rural	39.6***	25.5	1.92
2. Income/month (Rs.)	≤ 200 VS. 201 +	46.0***	32.0	1.81
3. Education	None VS. some	57.6***	41.1	1.95
4. Occupation		11.8***	9.3	1.92
B. Health status				
5. Health score		50.8***	29.1	2.51
6. Hb (g/100ml)	≤ 7.0 VS. > 7	9.6***	1.8	5.09
C. Reproductive status				
7. Age (years)	≥ 30 VS. < 30	24.9***	15.8	1.75
8. Parity (Previous LB)	≥ 4 VS. ≤ 3	13.9***	8.2	2.18
9. Previous still-births	≥ 1 VS. none	9.4***	3.6	2.80
10. Previous early neonatal deaths (Day 0-6)	≤ 1 VS. none	7.6***	3.4	3.60

*** $p < 0.001$

**In Case-Control studies ODDS Ratio (OR) stands also for "Risk Ratio" which should not be confused with Relative Risk (RR) of rates calculated directly.*

Source: Ref 44.

Table 11

Age at Marriage and Awareness of Legal Minimum Age of Marriage for Girls among Currently Married Women

State and year of the study	Age at marriage	% of currently married women who had no idea about legal age of marriage for girls
Bihar/1981	12.75	96.4
Orissa/1982	17.96	–
Rajasthan/1980	13.45	97.85
Madhya Pradesh/1985	13.8	–
Himachal Pradesh/1982	15.4	84.5
Haryana/1982	15.0	80.9
Punjab/1982	18.0	94.9
Maharashtra/1983	13.4	–
Gujarat/1983	15.75	–

Source: Ref. 30-33, 49, 50, 57-59.
Note: Unweighted averages have been used.

Table 12

Mean Anthropometric Measurements of Girls 10-16 Years

Age (years)	Kerala		Tamil Nadu		Karnataka		Andhra Pradesh		Maharashtra		Gujarat		Orissa		West Bengal	
	Height (cm.)	Weight (kg.)	Height (cm.)	Weight (kg.)	Height (cm.)	Weight (kg.)	Height (cm.)	Weight (kg.)	Height (cm.)	Weight (kg.)	Height (cm.)	Weight (kg.)	Height (cm.)	Weight (kg.)	Height (cm.)	Weight (kg.)
10+	126.8	22.9	123.6	21.6	127.9	22.4	128.9	23.4	128.1	23	123.2	21.1	122.8	21.3	121.0	19.8
11+	131.7	24.0	128.7	23.2	132.5	24.3	133.7	25.8	131.8	24.5	127.6	23.5	129	23.1	125.9	23.6
12+	133.8	26.5	133.2	25.8	137.1	27.3	138.5	28.2	137.5	28.1	134.5	27.2	137.2	26.3	132.0	24.5
13+	143.5	32.9	137.8	28.7	144	32.5	143.3	32.8	143.5	32.2	141.5	31.4	140.1	29.7	132.1	24.7
14+	149.1	36.6	145.3	34.4	146.3	34.2	145.1	33.5	145.8	35.6	144.8	35.4	143.0	34.7	135.8	32.5
15+	147.5	37.9	147.5	37.0	148.9	36.9	147.7	36.4	151.1	39.8	143.5	36.8	144.4	34.7	140.6	33.6
16+	150.4	40.5	148.7	38.6	151.0	41.9	149.5	39.8	151.1	43.0	152.6	39.9	146.8	38.1	148.6	39.9

Source: National Nutrition Monitoring Bureau, 1984.

Table 13

Percentage Distribution of Deaths in 5-14 Years Age Group

Major cause groups		Percentage Distribution
Accidents & Injuries	P	12.6
	M	12.4
	F	13.0
Child birth & pregnancy (maternal deaths)	F	–
Fevers	P	10.5
	M	10.4
	F	10.7
Digestive disorders	P	10.6
	M	10.8
	F	10.3
Coughs (disorders of respiratory system)	P	4.2
	M	2.8
	F	6.3
Disorders of central nervous system	P	7.2
	M	6.8
	F	7.6
Diseases of circulatory system	P	4.2
	M	3.8
	F	4.9
Other clear symptoms	P	6.8
	M	6.3
	F	7.4
All causes	P	4.8
	M	4.5
	F	5.2

Source: Survey of causes of death, Office of Registrar General, 1986.

Table 14

Awareness and Utilisation of Government Health Services by Women

Area	Tribal Madhya Pradesh	Gujrat[2]	Mahara-shtra[2]	Karnataka	Uttar Pradesh
Year	1986	1983	1983	1975	1982
Source: Reference	68	32	30	72	36
Awareness of health facility	88%	–	–	–	–
Aware of PHC*	–	4.9%	7%	–	–
SC*	–	27%	12.9%	–	–
Used Govt. health faculty[1]	32.7%	40%	–	34.41%	9%
Awareness of ANM/ LHV** visiting villages	–	62.96%	45.7%	–	–
Used services of ANM/ LHV**	2%	–	–	–	–
Visited at house by ANM/LHV**	16.6%	25.7%	18.5%	–	7%
Aware of availability of health guide	–	62.45%	35.65%	–	–
Aware of *Dai*	–	89.6%	47.84%	–	–

**PHC = Primary Health Centre.*
SC = Sub Centre.
1 = Not all visits were for their own needs.
*** ANM = Auxiliary Nurse Midwife [now called Health Worker (Female)].*
LHV = Lady Health Visitor [now called Health Assistant (Female)].
2 Unweighted averages have been used.

Table 15
Awareness and Utilisation of Government Health Facilities by Women During Antenatal Period

Place	Gujarat	Bihar & Kerala		U.P. (Rural)	Bihar*	Orissa*	*Rajas-than	Madhya Pradesh	*Hima-chal Pradesh	Hary-ana*	*Punjab	*Maha-rashtra	Guja-rat*
Year	1980	1981		1986	1981	1982	1980	1985					
Source: References		38		42	33	31	49	50	58	57	59	30	32
Pregnant mothers who have been registered	18.9%	–	–	–	4.92%	14.7%	3.9%	7.3%	21.6%	12.5%	23.76%	22.2%	11.5%
Pregnant mothers who have had check-up in clinic	–	15%	44%	4.3%	–	14.7%	3.5%	6.7%	11.8%	7.2%	22.3%	22.2%	11.5%
Pregnant mothers who were given Iron and Folic Acid tablets	–	4%	39%	14%	8.4%	–	6.7%	6.6%	–	–	–	26.2%	35.2%
Pregnant mothers who have received Tetanus Toxoid	18.9%	6%	38%	25%	10.15%	–	–	6.7%	–	–	–	28.6%	22.45%

Continued overleaf

Table 15 contd.

Place	Gujarat	Bihar & Kerala		U.P. (Rural)	Bihar*	Orissa*	*Rajas-than	Madhya Pradesh	*Hima-chal Pradesh	Hary-ana*	*Punjab	*Maha-rashtra	Guja-rat*
Year	1980	1981		1986	1981	1982	1980	1985					
Source: References		38		42	33	31	49	50	58	57	59	30	32
Pregnant mothers visited by health workers	–	–	–	–	6.32%	10.9%	13.0%	4.3%	11.5%	5.0%	6.1%	17.2%	29.0%
Pregnant mothers who were not aware of ante-natal regist-ration	–	50%	16%	80.7%	14.42%	9.6%	9.4%	32.9%	34%	12.36	26.5%	1.4%	2.4%
Pregnant mothers who did not feel the need for care in the clinic	–	–	–	–	42.17%	60.85%	50.5%	15.8%	15.1%	36.8%	46.4%	58.1%	8.6%

**Unweighted averages have been used.*

Table 16

Prenatal and Postnatal Services Provided to the Pregnant Women (Percentage Distribution)

Type of service	Gujarat	Rajasthan	Uttar Pradesh
Whether pregnancy occurred in the household during the last two years			
Yes	43.3	39.7	44.2
No	56.7	60.3	55.8
Prenatal/postnatal services provided by the PHC staff			
None	51.1	83.5	85.2
One or more	48.9	16.5	14.8
Sub-total	779	695	796
Type of prenatal services provided to the pregnant women by visiting staff*			
Visits made for home check-ups	42.8	9.4	11.1
Referral to PHCs	35.0	6.3	4.3
Distribution of MV/Iron tablets	39.9	11.1	7.2
Anti-tetanus injections	37.4	11.1	10.2
Advice on family welfare	40.2	11.1	7.9
Type of postnatal services provided to the mothers by visiting staff*			
Visits made within 1 week of delivery	25.2	4.6	3.4
Visits made within 1 month of delivery	18.7	3.0	2.8
Visits made between two to six months of delivery	30.5	1.5	2.3
Sub-total	382	115	118

* *Sum of the precentages exceed 100 as these % have been found for each type of service.*

Source: Ref. 28.

Table 17
Care During Delivery – Type of Birth Attendant

Place	Madh-ya* Pradesh	Bihar*	Orissa*	Rajas-than*	Maha-rasht-ra*	Gujar-at*	Hima-chal Prad-esh*	Hary-ana*	Pun-jab*	Tribal M.P.	Uttar Prad-esh	Uttar Prad-esh	Bihar	Kerala	Guja-rat
Year	1985	1981	1982	1980	1983	1983	1982	1982	1982	1986	1986	1984	1981	1981	1981
Source: Refs.	50	33	31	49	30	32	58	57	59	68	28	37	45	45	45
Delivery done by:															
Untrained *dais*	70.4%	84.7%	27.8%	87.15%	9.02%	68.35%	71.9%	60.3%	61.3%	98.8%	37.2%	35.2%	65.6%	38.1%	41.7%
Friend/ Relative	24.5%	12.37%	60.2%	5.8%	89.3%	10.5%	–	–	–	–	61.3%	45.3%	2.8%	5.6%	5.3%
Trained *dai*	**	**	**	3.4%	0.52%	16.75%	8.13%	16.5%	13.9%	1.2%	47.8%	7.6%	11.0%	30.1%	14.7%
ANM/ LHV***	3.1%	2.45%	**	3.6%	0.53%	3.55%	0.36%	0.16%	2.6%	–	22.5%	7.9%	11.0%	30.1%	14.7%
Government doctors	1.9%	–	**	–	–	–	4.96%	1.5%	7.3%	–	–	–	11.4%	3.1%	25.5%
Other trained persons	–	0.15%	12.0%	–	–	–	0.45%	0.46%	13.93%	–	29.7%	4.7%	5.3%	3.5%	10.9%
Others	–	0.12%	–	–	–	–	13.46%	20.6%	0.86%	–	1.5%	1.3%	–	–	–

**Unweighted averages have been used (only rural).*

** Definite/ *separate information not available.*

*** ANM = *Auxiliary Nurse Midwife (now called Health Worker [Female]).*

LHV = Lady Health Vistitor (now called Health Assistant [Female]).

Table 18

Utilisation of Health Services by Mothers in the Postnatal Period from Government Institutions

Place	Madhya Pradesh*	Maharashtra*	Gujarat*	Himachal* Pradesh	Haryana*	Punjab*
Year	1985	1983	1983	1983	1983	1983
Source: References	50	30	32	58	57	59
Visited by health worker	2.1%	9.05%	79%	16.1%	4.5%	19.43%
Visited health centre	3.7%	14.68%	85.7%	11%	5.76%	17.5%

* *Unweighted averages have been used.*

Table 19

Family Planning: Knowledge, Practice, Source of Information and Motivation

Place	Madhya Pradesh	Bihar	Orissa	Rajasthan	Maharash-tra	Gujarat	Himachal Pradesh	Haryana	Punjab
Year	1985	1981	1982	1980	1983	1983	1982	1982	1982
Source: References	50	33	31	49	30	32	58	57	59
Knowledge of method									
Tubectomy	95%	83.6%	86.2%	98.4%	95.96%	99.6%	94.8%	96%	86.5%
Vasectomy	93.8%	86.2%	82.8%	88.5%	93.71%	97.75%	94.8%	95.6%	82.4%
Nirodh	31.5%	28.1%	24.9%	20%	5.92%	31.85%	47.9%	46.13%	68.16%
*IUCD	28.6%	30.97%	34.6%	20.6%	3.67%	36.4%	39.2%	13.36%	41.5%
Oral pill	28.3%	24.3%	23.2%	6.83%	6.11%	23.75%	17.3%	10.56%	9.46%
ANM* 1 as source of information									
Tubectomy	–	3.2%	30.65%	5.6%	5.22%	28.3%	10.93%	3.43%	21.23%
IUCD	–	10%	36.7%	19.9%	38.57%	39.4%	19.1%	13.8%	34.73%
Oral pill	–	11.65%	34.9%	19.3%	47.07%	38.3%	–	–	–
Use of contraceptives									
Tubectomy	8.1%	3.45%	12.7%	5.05%	22.65%	22.9%	12.53%	15.86%	19.56%
Vasectomy	4%	3.05%	5.4%	7.5%	11.29%	12.75%	16.9%	8.63%	2.6%
Nirodh	1.7%		0.1%	0.35%	Less	0.2%	1.96%	4.1%	8.83%
IUCD	0.2%	1.1%	0.6%	0.25%	than	0.35%	0.6%	0.23%	3.1%
Oral Pill	0.1%		0.2%	0.05%	1%	0.15%	0.13%	0.06%	0.6%

Continued overleaf

Table 19 conted.

Place	Madhya Pradesh	Bihar	Orissa	Rajasthan	Maharash-tra	Gujarat	Himachal Pradesh	Haryana	Punjab
Year	1985	1981	1982	1980	1983	1983	1982	1982	1982
Source: References	50	33	31	49	30	32	58	57	59
Motivated by ANM									
Tubectomy	12%	–	–	4.75%	14.73%	44.1%	3.76**	8.93%**	39.7%**
IUCD	–	–	–	–	–	–	19.4%	28.5%	42.76%
Care after									
Tubectomy (good)	–	89.5%	90.7%	63.03%	88.0%	96%	–	–	–

Please note: Unweighted averages used for all the figures (rural).

* *Intra Uterine Contraceptive Device*

** *Tubectomy and Vasectomy.*

Table 20

Knowledge About Medical Termination of Pregnancy (MTP)

Place	Bihar	Orissa	Rajasthan	Maharash-tra	Gujarat	Himachal Pradesh	Haryana	Punjab
Year	1981	1982	1980	1983	1983	1982	1982	1982
Source: References	33	31	49	30	32	58	57	59
% who had knowledge about MTP	13.5%	23.7%	5.43%	6.43%	26.3%	31.9%	10.2%	45%

Unweighted averages have been used.

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Socio-economic And Socio-cultural Influences On Women's Nutritional Status And Roles

Meera Chatterjee

As women in Indian society are traditionally the providers of 'nutrition' within the household, and are also affected by malnutrition, as previous articles in this publication have established, "socio-economic" and "socio-cultural" dimensions of the subject of "women and nutrition" have two-fold significance. First, cultural norms and practices and socio-economic situations determine the extent to which women are able to affect the nutrition of the household at large; and second, they play roles in determining women's own nutritional status. These two aspects may be viewed as sides of the same coin as women are also members of the households in which they acquire, cook, serve, consume and store food, and their nutritional status is also part of the household's nutritional profile. However, what sets these dimensions apart, and makes them particularly interesting is the apparent contradiction that while women are in a 'commanding' position over the household resources that determine individual nutrition (eg. food, health care), they are themselves quite malnourished, often more so than other family members. What is the explanation for this? What are the determinants and some possible qualifying factors? This paper examines the socio-economic and socio-cultural influences on both women's nutrition related *roles* and their nutrition *status*, elucidating inter relationships wherever possible, and searching for clues to many unanswered questions, on the basis of data generated from several investigations carried out in the country over the last few years.

Socio-economic And Socio-cultural Influences On Female Nutritional Status

Synergism between gender and poverty: While socio-economic factors are well known to be important determinants of nutritional levels, and differences

in nutritional status between males and females have been widely documented, the *synergistic* effects of socio-economic levels and gender on nuritional status have been demonstrated less frequently. In an economic analysis of malnutrition among young children in Punjab in 1972, Levinson[45] found that gender was the most statistically significant determinant of nutritional status. It had a highly significant effect on caloric intake among the study population as a whole, and on diarrhoeal infection rates among the better-off Jats, with females having lower intakes and exhibiting higher rates of disease. The male-female differentials in nutritional status were especially great among the lower socio-economic/caste group, the Ramdasias. Nutritional status among the higher caste, land-owning Jats was better on the whole, and the gender differential was also small.

Levinson's study is virtually alone in its effort to separately quantify the effects of gender and social class on nutrition, and in establishing their additive significance. Furthermore, he found that both income and gender exhibited effects on nutritional status *independent* of their effects on food intake and infection. He observed that both high and low socio-economic groups discriminated against females in breast-feeding practices. However, as food resources were not scarce among the Jats, their young girls consumed as many calories and more protein, iron and supplementary food as young Jat boys. However, among the Ramdasias, discrimination against female children, coupled with lower purchasing power, meant that young Ramdasia girls had lower caloric intakes, consumed less supplementary food, and less solid food compared with Ramdasia boys, as well as with both sexes of Jat children. At about the same time, the Narangwal Population Study collected data which showed considerably higher infant mortality levels among Ramdasia females (196 per 1000 live births) than among Ramdasia males (125 per 1000), demonstrating the negative outcome of the poorer nutritional status of females[39].

In his study, the greater vulnerability of girl children was ascribed by Levinson to differentials in the care and upbringing of sons and daughters: "These differences reflect an economic as well as a cultural premium placed on living sons... (while) daughters are considered unproductive and an expensive economic drain, particularly the cost of dowry when they marry." This socio-cultural attitude considerably influences household nutritional care of girls and women.

In general, micro-level studies find higher rates of malnutrition among girls and women than among boys and men in the same age groups. Discrimination against females in matters of feeding already has visible effects on nutritional status during infancy[23], and these effects persist through childhood[9]. A few studies[22] have documented deterioration in nutritional status (cross-

sectionally) as females grow older, the combined result of socio-cultural, economic and biologic processes. Gender differences in adult nutritional status also appear to be exacerbated by poverty. Measuring anthropometric status of adults in different socio-economic groups in Tamil Nadu, McNeill[46] demonstrated the effects of social class, showing greater male-female differences among the poorest groups compared with the population as a whole.

However, in some contrast, the large-scale surveys conducted by the National Nutrition Monitoring Bureau between 1974 and 1982 draw a somewhat better picture of girls' nutritional status compared with boys'. For example, in 1980, while 51 percent of girls suffered from mild malnutrition compared with 44 percent of boys, the frequencies for moderate and severe malnutrition were — girls: 25 percent and three percent; boys: 39 percent and six percent respectively[53]. This pattern persisted in all the eight states surveyed in that year. One possible explanation for the contradiction between these national survey data and the ubiquitous finding by micro studies of greater malnourishment among girls is that while the former pool data on different socio-economic levels (and do not disaggregate gender within different socio-economic groups), the latter may be skewed towards poorer groups which have overall higher rates of malnutrition and, thus, also greater sex differentials in nutritional status. Micro level studies have the obvious limitation that they do not permit generalisations; their results are strictly applicable only to the communities studied.

Dietary intakes—and some demographic influences: Lower nutritional status among females is due at least partially to their more inadequate dietary intakes: Throughout their life cycles females receive less food than do males, and also "inferior quality" foods. Starting with breast-feeding, girl infants receive less milk, less frequently and over shorter periods than do boys [20, 38]. This situation may be exacerbated among the poor. A study in Tamil Nadu found that male children were breast-fed for five months longer than female children on the average. However, a male child in a *landed* family was breast-fed almost 10 months more than a female child in an *agricultural labour* household [46].

Furthermore, Das *et al.* [16] reported that this discrimination has special significance for girls born into families who already have a surviving child, particularly among low socio-economic groups, a finding that is supported by the observation that girls of high birth order have a greater mortality risk [17]. Weaned earlier, young girls may not get the required quantities of supplementary food, which predisposes them to higher rate of malnutrition and infection.

Another effect of the shorter period of breast-feeding of girl children is the likelihood of earlier ovulation and hence the possibility of subsequent conception by their mothers. The resultant shorter birth intervals after female births compared with male births (documented, for example, by Haldar and Bhattacharya[28], who analysed National Sample Survey data) increase the risks of malnutrition and mortality among female children, besides contributing to nutritional depletion of the mother.

Discrimination against females in the *quality* of food given has been shown, for example, in a study of rural Tamilian children[18]. Although both boys and girls received inadequate food compared with daily allowances recommended by the Indian Council of Medical Research, girls were worse off in terms of intake as well as in their weights and heights. Younger children received substantially lower proportions of the RDAs than older ones, but *gender discrimination* increased with age. Similarly, from across the country in Punjab, Das Gupta[17] reported that males received larger quantities of cereals, fats, milk, sugar and total calories than females in the zero to four years age group. The higher intake of calories and proteins by males of all ages has also been documented by studies in Bangladesh[12].

Regional variations: A collation by Harriss[29] of 24 household dietary intake surveys in the Subcontinent documents differentials between males and females by regions and season, in addition to age and socio-economic status. Nutritional 'equity' between males and females appears to improve from North to South. While in the North (exemplified by Rajasthan) all children under 12 and adult women were deprived of their fair nutritional "shares" relative to adult males as well as to the applicable RDAs, the gender differential dissappeared among adults in the western states of Gujarat (except for lactating women) and Maharashtra, and the southern states of Andhra Pradesh and Tamil Nadu. However, even in the latter areas, preschool girls tended to be worse off than boys, and some gender differentials occurred seasonally. In most instances, adolescent girls appeared to be as well or sometimes even better off than their male counterparts. In the East, the situation was similar to that found in Rajasthan, but the nutritional deprivation of women appeared to be *economically* rather than culturally mediated, as "work" played a significant role in female undernutrition. Females were especially deprived among poor families and in the "hard work" season.

While not permitting an examination of gender differentials within each socio-economic category, the National Nutrition Monitoring Bureau's dietary intake surveys document lower food consumption in households without land, compared with landowning households; among those who possess land but did not grow crops in the reference year, compared with those who did grow

crops; among labourers and "others" (village artisans and petty businessmen), compared with cultivators; and among scheduled castes and tribes, compared with non-scheduled groups[54]. While these distinctions are important for an understanding of socio-cultural and socio-economic influence on nutrition, one would wish that male-female differences were not obscured. The Bureau's data show that the proportion of individuals receiving inadequate calories is lower than the proportion of households with inadequate calories available for all consumers, which suggests that *the burden of deficit falls disproportionately on some individuals*. Extrapolating from other studies, one could surmise that these would be women and children, but the NNMB data are discrepant, once again, failing to show that females are any worse off than males in terms of caloric intakes *in the aggregate* (except for lactating women and among 13-16 year-old girls, as discussed below). The inconsistencies between these large-scale surveys and micro studies remain troubling. They can only be resolved in many different parts of the country, covering sufficient numbers of subjects in each age-sex-socio-economic group, and linking data on dietary intake and nutritional status.

Effects of "development": A comparison between data from the early studies of Punjab and more recent evidence shows that the social discrimination against young girls in matters of nutrition has persisted, despite the agricultural growth and economic development experienced in the area. Das *et al.*[16] found that 24 percent of female children among "privileged" families were malnourished, while 74 percent among the "underprivileged" suffered from malnutrition. Among male children, the percentages were lower in both groups – 14 percent among the privileged and 67 percent among the underprivileged – but still remarkably high. As Levinson had suggested, factors other than caloric intake – which can be broadly termed "child care factors" – remain crucial in bringing about these differentials in nutritional status. Das Gupta's study[17] in similar Punjabi villages found that the gender differential in food consumption among zero to four year-olds was in fact higher among *landed* than among landless families. She has suggested that *selective discrimination* is practised against second or higher birth order daughters, particularly among the better-off who aspire to smaller families, so that the "demographic transition" that has occurred in the region may, in fact, have worsened the status of the female child.

Indeed, an in-depth study of two villages in West Bengal by Sen and Sengupta[64] demonstrated that besides *a priori* differentials, the benefits of 'development' are also inequitably distributed among males and females. As in the Punjab studies, these researchers found that girls were more frequently and severely malnourished than boys in landless households than among the landed in both villages. The ratios of undernourished females to males in the two groups were 1.7 and 1.3 respectively. Following the adoption of land reforms in one village, the percentage of people owning land increased, and

undernourishment among zero to five-year-olds decreased. However, despite better overall nutritional levels, this village showed sharper sex differentials in anthropometric status, as only boys' nutritional status improved, while girls' nutrition in this village remained on par with that of girls in the 'underdeveloped' village. Thus, the economic benefits accrued selectively to boys. The finding by this study that a supplementay feeding programme helped to overcome the sex bias in nutrition to some extent is significant for policy and programmes.

Economic crises: In times of extreme food scarcity, female access to food is even more circumscribed, and girls suffer from malnutrition – and death – much more frequently than boys. A nutritional survey of some West Bengal villages hit by floods in 1978 showed a higher incidence of malnutrition among girls under six years of age compared with boys[44]. The female/male ratio of malnourished zero to five-year-olds was 1.07. If only moderate and severe malnutrition were considered, the ratio rose to 1.40; and it was 1.59 among severely malnourished children alone. In fact, females in all age groups (up to the age of 72 years) had higher rates of malnutrition than males[63]. These data illustrate that not only are females more likely to suffer from malnutrition, but that when they do, the severity of their malnourishment is greater. They also point, as before, to the synergistic effect of improverishment and gender bias, which has also been documented in Bangladesh[3].

Women's economic status and macro health indicators: Women's health and nutritional status are believed to be related to their "economic status" both at the micro (i.e. household) level, and the macro–or regional – level. The north-south dichotomy described above suggests that where females have a high economic status, they may receive a larger share of food and health resources; where their economic value is lower, they remain at a considerable disadvantage. At the household level, this relationship could be simply illustrated by studies correlating women's income or "economic value" with their nutrition or health status, but no definitive Indian study exists. There are, however, analyses of macro-level data from different areas of the country, based on indices other than nutritional status, such as mortality rates and sex ratios, which bear out this relationship. Two particular aspects of women's economic value have been related to their survival – their labour force participation, and their inheritance of property, including the payment of dowry.

Bardhan[4] first hypothesised that rice cultivation in the southern region of the country generates greater demand for female labour and hence supports higher female survival rates, compared with wheat cultivation in the north. Analysing sex ratios in different regions of the country, particularly female:male ratios among children under 10 years, Miller[48] found low ratios in the north and northwest , but less biased and even female-favourable

ratios in the south. There was a clear relationship between high labour force participation rates among 15-34 year-olds women's and young girls' survival. However, in some areas where female work participation was low, such as West Bengal, Assam, Orissa and Kerala, the sex ratios were not unfavourable to females. The author explained this in terms of a 'culture' favouring females, despite their economic suppression. The latter occurred in a general climate of economic backwardness, where female work participation was most likely negatively influenced by male work participation, because of severe restrictions in employment opportunities. However, the relationship between women's and men's employment is quite imperfect for, on the one hand, while men rather than women are likely to avail of limited opportunities, on the other, where men are underemployed, more women are likely to work in order to ensure resources to maintain the household. The implications of these different situations for women's nutritional status are likely to be considerably different, as socio-economic factors may 'play off' socio-cultural ones, as it were, there may be large 'macro/micro' variations, and temporal (eg. seasonal, annual) fluctuations are likely.

The analysis of women's work and survival is extended by the work of Rosenzweig and Schultz[61] whose two-stage regression of an all-India sample of rural households demonstrated a correlation between rainfall (i.e. wetland cultivation) and female employment, and then a negative correlation between female employment and the male-female survival differential. Higher female employment decreased the difference in the survival rates of males and females. These authors found that female employment was more significant than present wealth or parents' educational status in explaining variations in sex-specific survival rates. Significantly, a rise in male employment exacerbated the difference between boys' and girls' survival in favour of boys.

Regional differences in female survival are also related to the payment of dowry, a practice which is more prevalent in the north than in the south. Miller[48] noted that high dowry and marriage expenses were associated with adverse sex ratios. There is also an inverse correspondence between female work participation and dowry – the lower the former, the higher the latter. Thus, in areas where female work participation is low, the value of the girl child is considered far below her cost to her family who incur the expenses of her upbringing, marriage and dowry. The benefits of women's domestic labour are never considered as they accrue largely to girls' marital families and not to their natal kin. The low value attached to young girls also explains their lower education levels – low literacy and low school enrolment – in the areas where female survival and female work participation are low, marriage costs high, and early marriage and early childbearing the norms.

Adolescent girls: Considerable attention is currently being focussed on a previously neglected group, adolescent girls. However, our knowledge of the determinants of health and nutritional status among this age-sex group is quite limited. It is perhaps significant that the National Nutrition Monitoring Bureau data (which, as discussed above, do not generally demonstrate that females are worse off than males in dietary intakes) show that girls in the 13 to 16 year age group consume much less than boys, and only two-thirds of their recommended calorie intakes (in all states surveyed in 1982, except Karnataka)[54]. While 16-18 year-old appear to fare slightly better, they are still below requirement in all states. In addition, with the onset of menarche, young girls are highly susceptible to anaemia in the absence of adequate compensatory dietary iron. The prevalence of anaemia among women and children is extremely high, as shown by a study conducted by the Indian Council of Medical Research in four areas of the country[30]. It was found that over 95 percent of six to 14 year-old girls in the Calcutta area were anaemic, around 70 percent in the Hyderabad and Delhi areas, and around 20 percent in the Madras area. This has implications for women's productive as well as reproductive "success", as the relationship between anaemia and work performance, on the one hand, and low birth weight, on the other, are well established.

Indeed, society may fail to recognise the substantial work contributions of young girls, considering them an economic drain, as mentioned above. By the age of 10 or 12 years girls may be involved in eight hours of productive and domestic work per day, and by the age of 15 in 10 hours (for example[1], according to data collected in Nepal; there are virtually no quality "time-allocation" studies of Indian children, and few on adult women, mentioned below). In general, girls do more work than boys of the same age and, as one goes down the economic ladder, the work burden increases(for both boys and girls), thus increasing the likelihood of nutritional deficit. An all-India study of 4,000 rural households showed that the proportion of working girls among 10-14 year-olds was four to five times greater in landless households than among land-holding households, and they also worked four times as many days[60]. There are wide variations in the work patterns of young girls across regions (depending, for example, on opportunities available), by socio-economic levels, etc.[32] which can also greatly influence their nutritional status. In general, because girls engage in more unpaid domestic work and also receive lower wages for economic work than boys, thereby contributing less 'visibly' to household income, they are 'undervalued' and consequently deprived of adequate nutrition.

The period of adolescence is also one during which young girls are "groomed" to be wives and mothers, socially conditioned into their future roles, including that of tolerating food deprivation which will occur in adulthood. During this period, their life choices related to 'productive' activities are also made, through decisions related to schooling, careers, and so on.

While current thinking that this is a critical period during which interventions for physical growth and psychological development can be made is quite appropriate, there are as yet no studies to indicate that such interventions will have a positive and lasting outcome in the face of the stresses and strains that continue to face women in adulthood, although some efforts to examine these issues are in progress[43].

Even as adults, women may expend a greater proportion of family energy while getting a disproportionately small share of its food. Anecdotal evidence and a few studies[7,32,37] suggest that women work longer hours in paid and unpaid domestic work and thus expend more energy. Batliwala[7] estimated that women had a shortfall of 100 calories a day if their physical activity levels were considered, and men a surplus of 800 calories daily on an average in 560 households in six Karnataka villages, particularly if one included the energy demands of women's domestic work in the calculations. Unfortunately, the state of studies comparing women's work output and their dietary inputs is fledgling. These could be usefully done for different occupational groups, as their implications for wage levels, employment benefits, nutrition and health care and other protective legislation are potentially important.

Consequences of nutritional deprivation: A major consequence of girls' nutritional deprivation in early childhood and adolescence is their failure to achieve full growth potential[25]. The National Nutrition Monitoring Bureau's data on Indian women's heights and weights show that between 12 and 33 percent of 20-24 year-old women in the different states surveyed had height below 145 cm; and between 15 and 29 percent had weights below 38 kg. The percentages were even higher among younger girls – eg. 49 percent under-height and 67 percent under-weight among 15 year-olds in Kerala[24] – who have not yet completed their adolescent growth spurt, but who may yet marry and bear children at this early age. Below these levels of height and weight, women are at a very high risk of obstetric complications or of delivering low birth weight babies. Poverty also exacerbates the problem of low birth weight among children born to women of low height. For example, Ghosh *et al*[22]. found a 35.5 percent incidence of low birth weight among babies born to poor, short women, compared with 24 percent among those born to poor women over 145 cm, and 15 percent among babies of better-off, taller women.

Effects of early marriage and high fertility: The issues of marriage and fertility are germane because they affect women's nutritional status directly, as well as indirectly, through socio-cultural norms and practices that prevail after marriage and child bearing. They also have an influence on women's education and employment, which, as discussed at greater length below, exert considerable influence on household nutrition.

Indian women have one of the lowest mean ages of marriage in the world – 18.3 years for women in 1981[57]. As one would expect, women in rural areas are married at a considerably younger age than those in urban areas, and in some states, such as Rajasthan, Madhya Pradesh, Bihar, Andhra Pradesh, Uttar Pradesh and Haryana, the female mean ages at marriage are especially low. These low ages are reflected in the proportions of girls married among younger age groups. For example, 7.8 percent of 10-14 year-old girls in rural areas were married in 1981[57]. Among 15-19 year-olds, the proportion was considerably higher – almost half of rural girls and over one-quarter of urban girls, or 44 percent of all in the country. In Rajasthan, Bihar, Madhya Pradesh and Uttar Pradesh, the proportion exceeded 60 percent, while in Kerala, Punjab and Tamil Nadu, it is lower than one-quarter. Among women, "universal" marriage had almost obtained by the age of 24 years in most states of the country.

Among correlates of a higher female age at marriage, girls' education is paramount. An analysis of factors influencing age at marriage at the state-level found that, in addition to female and general literacy, other factors such as per capita income, level of urbanisation, non-agricultural employment and mass media, were also important[65]. At this level, women's participation in agriculture has a *negative* correlation with female age at marriage, because higher participation rates are indicative of more "traditional" communities. Thus, where women are married early, they are not only deprived of schooling and the benefits this may bring to nutritional awareness, but they are exposed to the 'double energy demands' of gruelling agricultural work *and* of early, frequent and prolonged childbearing.

The social pressure on young girls to "prove" their fertility is reflected in prevailing age-specific marital fertility rates. Among 15-19 year-olds, 17.5 percent of married rural females bore a child in 1978, and 19.7 percent of married urban girls[56]. For this age group as a whole (i.e. without distinction as to marital status), almost 10 percent bore a child in 1984[49]. The 15-19 year age group also accounts for eight percent of births occurring in rural areas[57]. More than one-third of all births take place among women under 24 years of age, and two-thirds to women under 29 years. Another five percent of births occur among women over 40 who are also at high risk of maternal and infant death because of *advanced* age. It is also significant that the proportion of higher order births is greater among women married under the age of 18 years[56]. Numerous factors, including rural/urban residence, religion, caste, occupation, educational level, household per capita expenditure, and age at marriage influence fertility, with the effects of the last three being particularly profound. Illiterate women have considerably higher fertility than do literates – more than twice as high among rural 15-19 year-olds and 30 to 50 percent higher among other age groups in rural areas, and as much variation among urban groups[56]. While their higher fertility is in part due to a lower

mean age at marriage, other factors, such as a higher desired family size, and higher child mortality rates are also important. Literacy results in fewer higher order births, with considerable differences between women having below primary level education and those with five or more years of schooling[56].

The high fertility of Indian women is one of the most detrimental socio-cultural influences on nutritional status because the metabolic stresses of pregnancy and lactation may not be adequately compensated by dietary intakes before (as we have seen above), during, or even after these physiological processes. Of a 30-year reproductive span, an Indian woman spends 16 years in pregnancy and lactation on an average. These years coincide with the years of women's maximum work burden in domestic work as well as labour force participation, as well as with the years when women are most socially subjugated.

Early childbearing is associated with higher risks of malnourishment and mortality to both mothers and infants. Girls may remain physically underdeveloped and hence are at greater risk of obstetric complications, obstructed labour and maternal death, as well as of bearing low birth weight infants, as described above. During pregnancy, women's access to food is even more restricted in the traditional Indian household through taboos and ritual observances which are widely documented. Birth weight is correlated with the pre-pregnancy weight of the mother, with weight gain during pregnancy, and with haemoglobin levels, so that the high prevalence of anaemia (discussed above) further exacerbates the negative outcomes of childbearing.

In a rare attempt to disaggregate some of these factors, Jesudason and Chatterjee[35] used path analysis to examine the inter-relationships between rural women's "pregnancy behaviour" (i.e. conceptions and completion or loss of pregnancies), nutritional status and morbidity, relating them to socio-economic and demographic factors. This study found that women's age and parity affected nutritional status, but that the effect on nutritional status of socio-economic level persisted when age and parity were held constant. Interestingly, the effect of total number of conceptions on pregnancy wastage was stronger than the reverse effect, but the effect of pregnancy on nutritional deficiency was greater than that of wastage. Several factors — nutritional deficiency, pregnancy wastage and socio-economic status – had strong effects on women's morbidity. While the programme implications of these findings were explored by the authors — eg. the need to integrate women's nutrition and health care with family planning strategies, more such work is required to completely understand the "inter-relationships".

Maternal and infant mortality: High maternal mortality in India is a reflection both of women's high fertility and of their poor health and undernutrition. Deaths due to pregnancy and childbirth accounted for around 12.5

percent of deaths among rural females aged between 15 and 45 years in 1986, and for 16 percent of those among 15-24 year-olds, who are at greatest risk of maternal mortality[58]. Several common causes of maternal deaths are related to malnutrition, particularly to anaemia, while other serious causes, such as toxaemia and septicemia, reflect the inadequate healthcare available to women in the ante-natal, internatal, and postnatal periods (see below).

The highest risks of death to both mother and child are associated with first births and those over four. Maternal age, age at marriage and parity are of course related: many first births occur under the age of 20; and girls who are married young are more likely to have high order births. Infants born to women married under the age of 18 years have almost twice the risk of death compared with infants of women married after age 21[55]. Low birth weight is certainly one factor explaining these relationships, and it is clearly related to maternal nutrition (as well as to maternal infections).

Another explanatory factor is inadequate "maternal competence," which is shown by the strong inverse relationship between infant mortality and education. Literate women in rural areas experienced an infant mortality rate of 90 per 1,000 live births, while among illiterate women the rate was 132 per 1,000. Thus, the effects of delayed marriage and education on women's and children's health could well reinforce each other.

According to the nation-wide 1979 survey[55], the high rural infant mortality rate reflected the high proportion of births (20-25 percent) which had a birth order of five or more. Another correlate of high infant mortality is "rapid" childbearing, or closely spaced births. Das[15] found that the mortality rate among children born between 1.5 and 2.5 years of a previous birth was almost half that of children born within a 1.5 year birth interval. With longer intervals the mortality rate decreased further. A survey by the WHO of 6,000 women showed that the mortality of infants born within a year of a previous birth was twice as high as that of infants born after two years of a previous birth (the infant mortality rates in these groups were 200 and 100, respectively)[21]. A spacing of between one and two years resulted in an infant mortality rate of 145, while a spacing of three to four years reduced the rate even further to 80. It is believed that a two-year spacing between births could reduce the aggregate infant mortality rate by 10 percent and child mortality by 16 percent. It could also reduce maternal deaths because repeated, closely-spaced pregnancies result in the nutritional depletion which renders a woman particularly susceptible to disease and death. These studies also point to another factor important to the survival of infants – mothers' previous child loss experience. Mortality was considerably higher among infants whose mothers had lost a previous child. Child loss shortens the interval between

births, and thus can aggravate the nutritional status of the mother through this route; but it is also related to "maternal competence," emanating from socio-cultural and socio-economic factors such as education and employment, which may in this way exert additional influence on women's nutritional status, morbidity and mortality. Ultimately, the compounded effects of women's low education and employment, early marriage and childbearing are a larger number of births, closely spaced, more nutritionally depleted women, and a larger number of maternal and child deaths.

There are also some discernible relationships between the survival of female children and their mothers' characteristics. The sex ratio of children 'ostensibly born' and surviving varies by the age of their mothers, being particularly low among mothers under 15 years[57]. The female child of the young mother is at particular risk of death because young women are under considerable societal pressure to produce sons. The extent to which they are subject to this pressure is also related to their social and economic status. For example, Bardhan[6] showed that a son preference correlates inversely with female earnings across the states. In other words where women's economic status is low, their social status is enhanced by mothering sons. As mentioned above, Das Gupta[17] has shown that second or higher birth order daughters are particularly at risk of death. In her study, the sex differential in mortality was more influenced by birth order than by economic or education levels.

While an attempt has been made here to document some of the relationships between socio-cultural issues concerning women and health and nutrition effects on them and their children using macro data sets, such as those generated by the Office of the Registrar General and the Ministry of Health and Family Welfare, little research has been done at the micro level which attempts to study the range of factors and disaggregate their effects through multivariate analysis, or to understand the processes involved. Thus, our knowledge of these important influences on women's nutritional status depends on piecing together disconnected (and sometimes disparate) sets of information. It would be most useful, instead, for concerted research efforts to be directed at these topics.

Women As Providers Of Household Nutrition

Women are "providers" of nutrition to their households in two distinct ways. First, they are instrumental in the *acquisition* of food through work, either on the family farm or as wage-earners in the agricultural sector or in non-agricultural occupations. Second, they *prepare* food for consumption (as well as for storage for *future* consumption). Thus, the most important social/economic/cultural dimensions which affect women's *provision* of nutrition are

women's employment and women's decision-making power vis a vis the disposal of their income (including marketing of food produced or purchasing food in the market), on the one hand, and their ability to cook and serve adequate quantities of food to individual household members, which encompasses their *nutritional knowledge* and "autonomy" in 'kitchen' decision-making, on the other. While the first section of this paper examined gender differentials in nutritional status as they are manifest under a variety of socio-economic and socio-cultural situations, this section approaches the subject of women's roles in the provision of household nutrition by examining the effects of women's employment, etc. on household nutrition.

Effects of women's employment through income: There is some evidence that women's employment has the potential to benefit household nutrition through increasing household income. Gulati[27] found that daily nutritional adequacy in agricultural labourer households in Kerala was related more to women's employment than to men's employment. She estimated that on days when both the male head of household and his wife were employed, their shortfalls in terms of calories were 11 and 20 percent, respectively, while on days on which the women were unemployed, the shortfalls increased to 26 and 50 percent. Shubh Kumar[42] found a strong association between child nutrition and a mother's income, and no significant association with a father's income, among low income households. Female children were particularly dependent on their mother's wages.

Women's decision-making power: An important question which arises is whether the relationship between women's income and household nutritional status is "direct" – i.e. exerted simply through the household's enhanced purchasing power and purchase of food – or "indirectly" exerted through an increase in women's status, power, autonomy or decision-making ability. On the one hand, there is evidence that women's participation in wage work alone may not guarantee them higher status in the household or greater decision-making power, as men (or non-working "mothers-in-law") usually control all household income, including women's wages. Harriss's[29] study of three Tamilian villages found that men controlled market decisions relating to food in 60 percent of households, and made joint decisions with their wives in another 15 percent of cases, leaving women primarily responsible only in 25 percent of households. In the majority of households women had some say in the "qualitative" issues (eg. the "choice of ingredients"), but did not have much say regarding quantities, regardless of whether they participated in wage work or not. In her study no clear differences emerged between "propertied" and landless households. However, in two of the three villages studied, there was some indication that women's roles were greater in the better-off familes while men dominated in the assetless families.

On the other hand, there is some evidence that women's earnings are spent preferentially on goods and services which improve the health of children, which would imply that both women's decision-making power and household health-related goods and services increase in tandem. For example, a study of women participants in Maharashtra's Employment Guarantee Scheme reported that the nutritional status of children was better when women received the cash or grain payments directly[60]. This finding agrees with those of Mencher and Sardamoni[47] which indicate that where women exercise control over their wages, they spend them on food and other basic needs, while men apparently tend to spend portions of their wages on liquor, cigarettes, etc. Additional documentation of these phenomena are, however, called for before definitive judgements are made.

Other characteristics of female employment: Some other characteristics of women's employment also have important implications for household nutrition. Among poor households, the *seasonality* of employment has both direct and indirect negative effects on household nutrition. The former occurs through the high energy demands of peak work seasons, and the latter through the resultant fluctuations in intra-household food availability. For example, Palmer[59] reported that pregnant/lactating women often lose weight during peak work (low food) seasons, and infants may be summarily weaned at such times. As women's agricultural work tends to be seasonal because of its task-specificity, households that are dependent on women's work for their nutritional adequacy would be especially vulnerable. Seasonal variations in food availability often exaggerate differentials in food intake between men and women. When more food is available, it appears to be preferentially allocated to males, thus increasing the gap. However, in households with low average food availability, women and children are especially at risk during lean periods and may fall below the survival line, as the shortfalls in caloric intake would be exceedingly drastic. Even among slightly better-off households, discrimination against females in the allocation of food renders them more susceptible to malnutrition. The availability of off-season employment and food-for-work schemes may mitigate these detrimental effects of agricultural seasonality on nutritional status to some extent. However, the effects on women's nutritional status or roles or on household nutrition of large-scale employment provision programmes involving women have not been systematically studied in this or other respects.

Other employment-related factors such as the *location* of work-sites relative to homes, the time spent in work and in travel, the energy cost and ergonomic nature of the work, or the provision of *child care facilities* at work places may also greatly affect women's nutritional roles (see below).

Women's productive vs. domestic roles: There may also be some signifi-

cant tradeoffs between women's productive and domestic roles. In their detailed study of an Andhra village, Bidinger *et al.*[8] found that employment in the household in general, but also of female members specifically, was a major factor affecting the energy intakes of children under six years of age, and the equitable allocation of food resources. Female employment was a more significant determinant than income or landholding size. Female labour participation contributed significantly to the dietary intakes of children. The authors hypothesised that working women have more say in food distribution within the family "as male members see them as more competent". On the other hand, they also suggested that while malnutrition in poor households was due to the lack of food, among medium and big farm families, women who hire and supervise labour have little time for child care, which precipitated some of the severe malnutrition the researchers observed among children in such households in their study. In this context, the contention by Mencher and Sardamoni[47] that in landless and small farm families women must work because men cannot meet household expenses entirely is significant because of the consequent lack of choice afforded the poor family. Among the poor in particular, the additions to household nutrition made possible by women's employment may not totally offset the detrimental effects of women's absence from the home on child feeding and care.

In fact, women's employment in the organised sector or even in informal sector self-occupation has been considered inimical to breast-feeding because of mothers' time away from home[21], coupled with society's failure to legislate for adequate provisions or enforce existing legislation. Only among certain occupational groups, and then too for very limited numbers, are there viable arrangements which permit women to take care of the nutritional needs of their infants and young children. "Mobile creches" are available for women in the construction industry in a few metropolitan areas, and day care centres are to be established by law for women in the plantation sector. While employers of women in factories and mines are also required to provide such facilities, they remain inadequate. The large majority of women workers in agriculture are not served by such facilities, except in areas where the Integrated Child Development Services Scheme has been established. Even here, the attendance of infants and toddlers at *anganwadis* is low, as their mothers prefer to take them to the fields or forests – or simply leave them at home – rather than in the care of the worker. The situation of urban, self-employed women – vendors, petty traders, domestic servants, etc. – is even bleaker as they lack access to institutionalised child care as well as the traditional joint family system. Unfortunately, there is little or no quantitative information on the effects of different female occupations on the nutritional status of children, of the women themselves, or of other household members, as mentioned above. Nor are there good quality research studies on the effects of support services provided for the few occupational groups mentioned or of different child care situations on overall 'home nutrition management'.

In sum, while there are indications that women's work can bring about improvements in household nutrition, particularly if women have control over their wages, there are numerous unanswered questions on the issue of women's employment and nutrition to which research could be fruitfully directed. Does women's work enhance the quantum of food or health-producing goods and services available to the household? Are women's wages *preferentially* allocated to nutrition and health care, so that one could argue that women's wage employment improves family well-being more than men's wages? Are working women more knowledgeable about nutritional needs, food values, etc.? Do they make more or better decisions in favour of nutrition? Carefully designed studies which disaggregate the effects of (prior) socio-economic status, women's specific income, education levels, etc. are essential, and the 'black box" of household decision-making must be prised open carefully.

Research on women's work and nutrition must seek to establish whether and if so under what conditions women's employment brings about health improvements – among the working women themselves, of the children for whom they are directly responsible, and of other members of their households. It must also document the nature of these improvements, and the processes by which they are achieved. Further, in order for the strengths of the relationships to be established, the research should also identify any confounding factors and ascertain any disbenefits. For example, if women working outside the home allocate time to productive activities which would otherwise be spent in domestic work, notably child care, the 'disbenefit' of diminished child care to child health must be evaluated against the benefits of women's increased income.

The policy implication's of such research could be far reaching, encompassing actions such as the promotion of appropriate employment options specifically for women, legislation of women's wages for different types of work (eg. through the Minimum Wages Act and Equal Remuneration Act), provision of support services for productive and domestic work, including creche and child care facilities, development of "drudgery-reducing technologies" and services such as fuel and fodder, water supply, and so on. An understanding of household decision-making processes may strengthen policy-making and action in vital social arenas such as education.

Women's education: Considerable attention has been drawn in the first section of this review to the effects of education on nutritional status of women. Although women's education is now hypothesised to exert a major influence on health and nutritional status, some definitive primary investigations are called for to establish the extent and nature of the relationship, as well as investigation of the intermediary mechanisms. Available analyses tend

to focus on the relationship between women's education and child mortality at the macro-level. Using data from the 1979 Survey of Infant and Child Mortality[55] Jain[31] established that female education and household economic status were important "household-level" factors explaining mortality variations. Female education had a particularly strong inverse relationship with infant mortality. In the country as a whole, illiterate mothers experienced 145 infant deaths per 1000 live births, while those with some education had an infant mortality rate of 101, and those with primary education had 71 deaths per 1000 infants born. In rural areas, infants of illiterate women had a mortality rate more than double that of infants whose mothers had a primary school education (132 and 64, respectively), while in urban areas the difference was reduced to two-thirds higher among illiterate women (81) compared with primary schooled women (49). This suggests that other 'urban factors', such as the availability of health services (see below) can partially offset the detrimental effects of female illiteracy on infant mortality. However, poverty may be an over-riding *negative* factor, as analysis of the infant mortality rates of different states shows that while the IMR decreases with increasing female education, the relationship does not hold in some states such as Assam and Andhra Pradesh.

The mechanisms whereby women's education results in lower child mortality have been the subject of some speculation – but little investigation. As child health and survival are enhanced by better hygiene, improved nutrition and feeding practices (of the child as well as of the mother) and timely medical intervention, education may improve women's practice of any of these. Schooling may enable women to take independent decisions and act on them. Educated women may have greater roles in household decision-making, and be permitted by other household members to pursue appropriate strategies. In Bangladesh, D'Souza and Bhuiya[13] showed that household decision-making does indeed change with the education of women, with greater shares of household resources becoming available to women and children. Clearly, the effects of women's education on their own nutritional status and on that of their children is exerted through their roles as providers of household health and nutrition care.

In fact, when it comes to child nutrition, mothers' knowledge may be more important than income. Bairagi[2] studied the relationship between child nutrition and factors such as family income, maternal education and birth order. He found that income was not the only constraint on nutritional status, even in the lowest income group. Maternal education had a significant influence on nutritional status, as did the child's sex and birth order. A literate mother used scarce resources better for her child's welfare than did an illiter-

ate mother with higher income. Sen and Sengupta's[64] study of two villages in West Bengal showed that children with literate mothers fared better than those with illiterate mothers in terms of nourishment. However, these authors suggested that "literacy and prosperity" went hand in hand as the beneficial effect of mothers' education was greater in the village where there was a higher degree of "urban integration". In Das Gupta's[17] study of Punjabi villages, women's education was associated with reduced child mortality, but she found that education increased the discrimination against girls of higher birth order, perhaps because with education women desire smaller families with only one daughter. In Punjab, education may also increase rather than decrease the quantam of dowry required to marry off daughters because it is not clearly related to the "economic value" of women.

A general conclusion emerging from these studies is that while a minimum level of income is necessary to ensure child nutrition and health, income alone is not sufficient to guarantee child health. This underlines the need to emphasise both women's employment and education as the means to improve health and nutrition. Both educated and earning mothers are believed to have greater "autonomy" which is reflected in better child care practices, including use of health services.

Women's access to health care: Women's access to health care affects their roles as providers – or 'protectors' — of household nutrition in a variety of ways. Firstly, as the first-level health care provider within the household, a woman's knowledge of good health and nutrition practices is important to ensuring "protection". Although such knowledge may be gleaned elsewhere, eg. in school, from older family members or other informal networks, as formal health systems become increasingly concerned with health "promotion", they are important conduits of health knowledge. Secondly, health services offer the next level of support to the household when treatment is required, or in the arena of preventive health action. Thus, the health of family members is guarded by ensuring women's access to health care. A third way in which household health and nutrition status is affected is through *the health of the woman* herself. Women's health is part of the health profile of the household *and* it determines the extent to which women can effectively carry out their multiple roles as producers, mothers, child-minders, etc., all of which affect household health. Antenatal, intranatal and postnatal care affect the viability of infant and the survival of both mother and child; nutritional care affords better health during pregnancy and lactation, as well as energy for work, etc.; family planning services address issues of birth spacing, family size limitation, and so on. Clearly, women's access to health care influences their

nutrition and health status as well as their nutritional roles.

However, our understanding of the role of 'access' is complicated because it is not only a *determinant* of women's nutrition and health status but also the *outcome* of women's status in society. Thus, both health status and access may be simultaneously affected by socio-economic and socio-cultural factors, *and* negatively reinforce each other. Women's *access* to health services implies both the latter's physical approachability and a favourable social and economic situation for the woman. Actual *use* of health services by women is a function of their *need,* as defined by morbidity levels, the extent to which they are socially *permitted* to approach health service providers in either the traditional or "modern" medical sectors, their *ability* to do so in an economic sense, and the *availability* of appropriate services[10]. Unfortunately, there are no studies which have examined all these factors – which would require assessments of need and of knowledge, attitudes and practices at the household level, linked with a study of available health services. It would then be necessary to tease out the relative contributions of the various factors to nutritional status, as well as to examine their inter-relationships. Therefore, our understanding of this topic is pieced together from data on female morbidity accessed separately at health centres or at the household level, and usually divorced from information on health service utilisation, again collected separately at household and health centres.

Available studies focus on the differential access of males and females to health services, particularly among children, sometimes relating this aspect to nutritional levels or morbidity rates. For example, Gopalan and Naidu[26] showed that while females outnumbered males 4:3 among children suffering from kwashiorkor, more than half of hospital admissions were of boys. Similarly, Dandekar's[14] survey of 37,000 people in rural Maharashtra revealed that although a higher percentage of girls were ill than boys, lower percentages received medical treatment in the group under 15 years of age. These studies imply that households discriminate against female children in terms of health care, a phenomenon that is merely an extension of the other forms of discrimination discussed above, all related to the lower status accorded to female children. More recently, Das *et al*[16] observed that girls in Punjab were taken to less qualified doctors than were boys, and Das Gupta[17] found that expenditure on medicines was higher for boys than girls, particularly during infancy, and among better-off families. Among infants, about two-and-a-half times more expenditure was incurred on medicine for boys while among all zero to four year-olds, the ratio was 1:2. The ratio was higher among the landless (1.55) than among the landed (1.10).

In fact, in Punjab, better and more timely medical care for boys may be the most important factor explaining high survival among males compared with females, as early studies showed[39,62]. In his effort to explain the declining sex ratio in the country at large, Mitra[50] noted that treatment is most often sought later (during illness) for girls than for boys. This had been documented by the Narangwal Population study: while 48 percent of female children were treated in the first 24 hours of their ultimately fatal illnesses, 64 percent of boys were treated[39].

There is differential use of health services among adults as well. In Dandekar's[14] study, a greater proportion of ailing women than men received no treatment, and those women who were treated received mostly home remedies or traditional medical care, while men received institution-based care. Hospital and clinic attendance records invariably show a preponderance of males receiving treatment. Listing several studies of hospital admissions in different parts of the country, Miller[48] showed considerably higher ratios of male to female admissions in northern hospitals (eg. 2.1:1) compared with southern hospitals (1.3:1), although males were clearly favoured in all areas. The proportion of treatment provided to women in general is lower whether one considers out-patient attendance or indoor admissions. For example, in one study of admissions to Safdarjung Hospital, Delhi, only 35 percent were female[20]. Similarly, Khan *et al.*[38] reported that a larger number of males were treated at Primary Health Centres in U.P., Gujarat and Rajasthan. Another study of Primary Health Centres in Rajasthan revealed that five men received medical treatment for every woman[51].

These findings are even more significant in the light of reports from household surveys that more women than men report illness. In U.P., Khan *et al.*[37] found more episodes and longer durations of illness among women than men in the 20 families they studied closely. They noted that female morbidity was likely to have been underestimated because women were "shy" to reveal illnesses, or purposely downplayed them to avoid seeking medical care. As this study and others (cited above) have noted, the result is that women tend to seek medical help only at advanced stages of illness, which greatly reduces their chances of recovery or even survival. This is corroborated by hospital-based data which show that case-fatality is higher among female patients[44].

While there are few studies that compare the health of women and men in the same household, those which exist generally report a higher prevalence of illness among women[34,37]. One study followed 110 familes over a two-year period and found a significant difference in the number of illnesses suffered by "mothers" compared with "fathers" (10.8 episodes per year compared with

6.0)[36]. However, some research in Bangladesh failed to find a gender difference in the *incidence* of disease[12] and those authors contend that higher female morbidity is largely the result of the lack of treatment of female illness.

The existence of low treatment rates despite the availability of free government health services in both rural and urban areas suggests that social strictures and/or the economic costs of seeking health care (either "opportunity costs" to domestic or paid work, or direct costs on transport, medicines, etc.) are daunting to women. "Quality of service " issues are important on both scores. Khan *et al.*[37] found that in the U.P. villages they studied, only in nine percent of female illnesses was treatment sought from the nearby PHC or government health facility. The vast majority of women simply used traditional remedies. In a household health survey in Madhya Pradesh, we found that while treatment had been sought for about one half of reported 'current serious illnesses', only 15 percent of patients had approached government facilities, the remainder seeking private allopathic or traditional medical care[34]. Women's attendance at sub-centres or PHCs for 'preventive' and 'promotive' health services (eg. antenatal care) is similarly low. While official statistics maintain that three-fourths of deliveries in rural areas are conducted within homes with the help of female relatives, friends or *dais,* micro-studies report proportions closer to 90-95 percent[33,38].

In the Madhya Pradesh survey, many of the respondents who had visited government facilities complained of having to travel long distances, lengthy waiting times, lack of adequate personnel or medical supplies, or the "rude behaviour" of staff[34]. Such complaints in turn discouraged other potential users, although poor knowledge on the part of consumers of the health services available appeared to be a major constraint to use. Only one-third of the women respondents in this study knew the location of the nearest sub-centre, and about 40 percent the location of the nearest Primary Health Centre. Knowledge of the working timings of these facilities was even poorer. Only a quarter of the women had actually ever visited the local sub-centre, and less than 20 percent the PHC. In sum, to encourage *use,* the health services have to improve 'consumer education' as well as the management of health services so that some of the constraints in the social and economic arenas are removed.

There are significant regional differences in the availability of health services, which may partially underlie male-female differentials in health and nutrition. Bardhan[5] established that mortality levels in different states were related to various health care variables, such as *per capita* health expenditure, trained birth attendance, numbers of hospital beds,etc. Dyson and Moore[19] have pointed to geographical differences in trained birth attendance, which is

lowest in the north and north-western regions, and highest in the south, a pattern that roughly coincides with the status of women in the different regions and is inversely related to mortality. Indeed, where infant mortality has declined in the country (eg. in Kerala, Goa, etc.) this has been ascribed, among other factors, to the availability and women's use of health services.

Analysis of the nation-wide Survey of Infant and Child Mortality[55] provides some important pointers to the role of women's use of health services in explaining state-level variations in child mortality. Among factors that operated at the individual level, trained medical attendance at birth had a strong positive influence on infant survival[31]. At the household level, factors such as female education and household economic status were found to be important, as discussed above. However, the availability of health services was important in explaining urban-rural differences in the mortality-reduction effects of literacy (among other factors, such as clean water supply). At the village level as well, the availability of health services contributed to better infant survival. In essence, these data show that the presence of health facilities and of trained birth attendance are important to the reduction of infant mortality, ie. their availability stimulates use by women at least for the purposes of child health care. Both household economic levels and female education are important mediators in this process.

The hypothesis that women's use of health facilities and female literacy go hand in hand in reducing mortality is further supported by other studies. Krishnan[40] found literacy an important variable to explain differences in mortality rates at the state-level (in a selection of states). He examined overall death rates in terms of literacy, doctor-hospital-and-bed-population ratios, per capita incomes, urbanisation and state per capita expenditure on medical and health services. While literacy was the most important factor, the health service ratios also had some explanatory power (although health expenditure was not particularly significant).

Studies which focus on Kerala (the state with the highest female literacy and lowest infant mortality rates in the country) bear further witness to the effects of women's literacy and the availability of health care on mortality. Krishnan[41] and Nair[52] showed that the infant mortality rates of different regions in Kerala were positively correlated with the size of the "catchment areas" of health centres, i.e. infant mortality was lowest where access to health facilities was easiest (the "lowlands") compared with areas of difficult access or small catchment (the "highlands"). Comparing different districts of Kerala, Zachariah and Patel[66] showed that infant mortality was most influenced by mothers' education and that household expenditure was also significant. Social factors such as caste and demographic ones such as birth order were also important.

In sum, both the development of health services in the state over the past two centuries and female education are associated with Kerala's impressive mortality and fertility declines. Indeed, it is because of high literacy levels that public health measures are believed to have been effective. Literacy made people more aware of health problems and activities, enhanced people's participation in mass campaigns, and created a demand for health services, which in turn stimulated supply. Trained birth attendance was an early feature of Kerala's demographic transition. The education system in Kerala simultaneously emphasised the education of *women* and *health* education. It also directly furthered health and hygiene through mandatory vaccination of school children, teaching of health science subjects, and channelling of girls into the nursing profession. The matrilineality of Kerala society – and hence women's higher status – permits Keralite women to exercise influence on the health and welfare of their families, and to use health services which are spatially well distributed. Thus, in Kerala, women have been beneficiaries as well as participants in the health development process[11].

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Part II
Bibliography

Editor's Note

We are grateful to the several scientists and institutions which extended their generous cooperation towards the compilation of this bibliography. The limitations inherent in a compilation on nutrition of this kind have already been mentioned in the preface.

The bibliography has been organised under seven headings namely:

1. Pregnancy and Lactation.
2. Growth and Development.
3. Deficiency Diseases.
4. Demographic Considerations.
5. Nutrient Requirements.
6. Socio-economic Aspects.
7. Women and the Health System.

The Foundation hopes that with the cooperation of fellow scientists, this bibliography could be periodically updated.

Suminder Kaur

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